POWER

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Early American Steam Engines

THANKS to the complete record kept by Josiah Hornblower we have a good account of the first installation of a steam engine on this side of the Atlantic.

It was a Newcomen pump, erected in 1753 to keep a copper mine on Schuylers Point, in Newark Bay, free of water.

Some twenty years later another Newcomen engine was ordered for the water-works of New York City. It was set up in 1776, but the system of which it was a part proved inadequate and was abandoned as the Revolutionary War went on.

Not many Boulton & Watt engines appear to have found their way to America. One of their pumping engines was bought by the City of Philadelphia for its water-works. Robert Fulton had to get the ban prohibiting the exportation of Watt engines—and which may be in part responsible for the small number brought over—raised in order to import, in 1806, the engine for the Clermont.

William Henry, John Fitch, James Rumsey and Col. John Stevens built a number of engines, all however, for propelling boats.

Oliver Evans was interested in the application of steam power to travel on land rather than on the water. He built a small stationary engine in 1801 and used it to grind fertilizer and to saw marble. A larger engine, while awaiting installation in a Mississippi steamboat for which it had been ordered, was used to saw lumber and to drive a cotton press. These are the first, or among the earliest, applications of steam power in American industry other than for pumping and for transportation.

Evans established the Mars Works about 1807, and at the time of his death, in 1819, some fifty of his engines were in use. He was thus the first regular American manufacturer of steam engines.

A group of American members of the Newcomen Society, an organization "for the study of the history of engineering and technology," desires to gather and put upon record, while it may still be obtainable, information regarding the penetration of the steam engine into American industry. Further particulars of those that have been mentioned or of other early examples, as well as references to sources of information upon the subject will be gratefully received.

EDITORIALS

Public Ownership Sidesteps Utopia

ECHOES from congressional halls and a state government or two would make it seem that the proletariat has a little less than the proverbial chance for life against some hard-shelled monster they call the "power trust."

It is also inferred by the same coterie that the remedy for all the alleged evils of the present system of private ownership and operation of utilities and the short cut to Utopia is some form of public ownership.

Another group claims that the so-called power trust is not an issue and that efforts to make it one are purely political.

Power holds no brief for either protagonist. Nevertheless, there is nothing in history, nor in the signs of the times, to warrant the belief that the very things the advocates of public ownership find objectionable in the present system of private ownership will cease to exist under the new order they would inaugurate.

Human nature and the things that motivate men to self-interest may be depended upon to create conditions no less acceptable under public ownership than they are now.

Consider the attitude and viewpoint of a West Coast municipal utilities district toward its neighbor. Both are in the public ownership group and operate municipal water supply projects with hydraulic power as a byproduct.

The city of San Francisco has been building its water supply for the past fifteen years or so, but is in danger of a water shortage pending completion. The East Bay Municipal Utilities District has an abundance of water, made available through the completion of its project.

The one needing help has signed a contract for an emergency water supply. The President of the more fortunate East Bay Municipal Utilities District comments on the contract, in part, as follows:

"How much is it worth to the people of the East Bay Municipal Utilities District to have it heralded that they saved San Francisco from a water shortage, if not a water famine?" . . . The statement of these bald facts isn't 'rubbing it into' our municipal neighbor either. Really, though, now you know, wouldn't there have been at least some little 'rubbing it in' had our positions been reversed? . . . If, as she almost certainly will, San Francisco takes 20,000,000 gallons per day, she will pay us more than $1,250,000. If she doesn't take a drop of water from us, she will pay us the $292,500 'stand-by.' . . . "A gross income from San Francisco of $1,250,000, or even half that sum, is a scrap of 'velvet' that is not to be sneezed at—don't you think?"

Were the transaction between a private seller and municipal buyer the attitude would not be more reprehensible nor subject to greater criticism.

With this expressed relationship between two sets of public servants, what, more than private business offers, does public ownership hold?

The Outdoor Power Plant

TRENDS in substation design have been toward the outdoor placement of equipment. High-voltage oil circuit-breakers and transformers led the way and demonstrated that electrical equipment could be designed to operate successfully when exposed to all kinds of weather. Now there is a decided movement for omission of the superstructure in hydro-electric plants and protection of the generators only against the weather. Several such plants are in service.

Much of the experience gained with outdoor air-cooled synchronous condensers may be applicable to turbine-generators. Some of the reasons for housing air-cooled turbine-generators would be eliminated by the use of hydrogen cooling. A number of outdoor hydrogen-cooled synchronous condensers have already been put into service. The first hydrogen-cooled generator, although of the indoor type, went into successful operation last year.

Many of the reasons for opening air-cooled machines disappear entirely when hydrogen cooling is used. Even with a closed system of air-cooling, dirt and vapors find their way into the machine and make inspection and

cleaning necessary. Hydrogen cooling will insure clean windings, and corona has little effect in an atmosphere of this gas. The insulation should therefore be less liable to failure. Fire cannot occur in the hydrogen-cooled machine, due to the absence of oxygen; consequently no special fire protection need be installed.

Obviously, there are other problems than the generator to be solved before the outdoor steam plant becomes a reality in northern climates. The hydro plant has been made automatic in operation and requires little attention, a state of development not yet fully attained in the steam plant. A considerable part of the hydro plant is installed in the substructure, whereas the steam turbine unit is largely above the foundations. This, however, is no bar to discussion of the outdoor plant, and experience with one high-pressure station that is now being built in California will be followed closely.

Heat, Light and Power Costs in Hotels

LAST MONTH Edward C. Romine, C.P.A., presented to the West Side Association of Hotels, New York City, his analysis of their power, heat and light costs based on a questionnaire that they had filled out. This report, much of which is printed elsewhere in this number of *Power*, develops conclusions that will surprise many engineers, but the author's position as a hotel accountant, with engineering background, warrants consideration of his paper.

Mr. Romine points to an average coal cost per year per room of $18 for the hotels using low-pressure steam, and $30 for those using high-pressure steam, as conclusive evidence that high pressure *per se* increases cost. The matter is certainly worthy of further investigation, but such general conclusions are dangerous.

It is a common fallacy to assume that when two facts occur simultaneously one must be the cause of the other. By similar reasoning one might "prove" statistically that leaving the salt out of butter greatly increases the cost of food service in hotels, or that the employment of a footman to open cab doors enormously increases the payroll per guest.

This is not to prove that Mr. Romine's conclusions are wrong, but merely to point out that his evidence is altogether inconclusive.

On the other hand, it seems more easy to accept his conclusion that hotels generating their own electricity therefore consume more kilowatt-hours per room. Undoubtedly, where no attempt is made to meter the locally generated current or to hold department heads accountable for waste, consumption will mount. But what in the world is to prevent the application of such checks in hotels generating their own current?

With Mr. Romine's concluding point none can disagree. He urges the importance of a daily accounting to prevent waste of fuel and other costly consumables.

It All Started In a Drug Store

IN 1883, nearly fifty years ago, Truman J. Pearce, a pharmacist, and Melvin W. Beardsley, a Pennsylvania oil expert, were in the rear of the former's small drug store in Santa Barbara, Calif. Pearce was making carbon bisulphide, a gopher poison, while Beardsley sat on a barrel of thick black tarry substance, later known as black paraffine, which he had obtained as a residue in the distillation of crude oil.

They had sought almost in vain for a solvent of this black paraffine, to be used as a paint, as it was very resistant to acids and alkalies. By accident, Pearce spilled some of the carbon bisulphide on the paraffine and found it to be the long-sought solvent.

Finding a solvent for the black paraffine was their first step toward making paint and the formation of the Paraffine Paint Company, in July, 1884, capitalized at $1,000,000. Their first marketed product was "P. & B." paint. Shortly thereafter Pearce and Beardsley originated a prepared roofing which they made by coating burlap with asphalt.

In 1906 they substituted felt for burlap at the time when the San Francisco earthquake and fire created an abnormal demand for prepared roofing of that nature. From the search for a greater field for its base products, the felt-base, asphalt-coated floor covering of many different designs followed.

Today the "Paraffine Companies, Inc.," capitalized at $25,000,000, conduct a world-wide business in paints, varnishes, enamels, lacquers, roll roofing, mineral surfaced shingles, building papers, enameled rugs and pipe covering.

All this means process steam and power in large quantities. It opens the opportunity for the economic interrelation of these services by the application of sound engineering analysis.

This opportunity has been seized by the management of the Paraffine Companies, Inc., and by their consulting engineers. The resulting power plant design, as presented in this number of *Power*, is decidedly novel and interesting. In particular, process plants everywhere will profit by studying the flexible arrangement of evaporators. Other unusual features are the arrangement of auxiliaries and the elimination of the usual wall between turbines and boilers.

POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

The Paraffine Companies, Inc., Ba

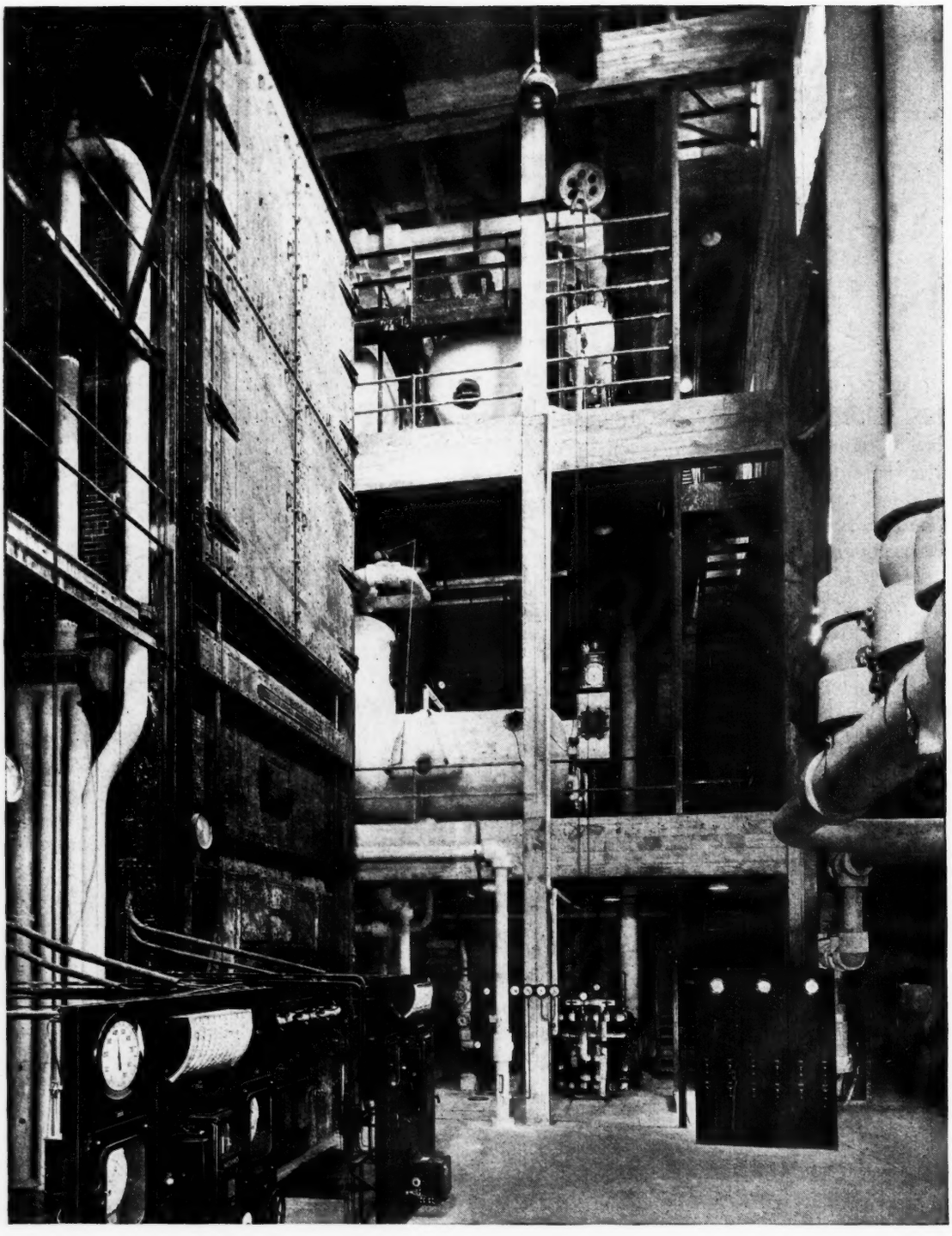

Fig. 1—Most of the auxiliaries, including evaporators, are located on the mezzanine floors

Balance Power and Steam With Variable-Effect Evaporators

An industrial power plant unique in layout and operating method has been built for the Paraffine Companies, Inc. Operation of evaporators single-, double- or triple-effect helps balance power and steam loads. Other features are equipment arrangement and 425 lb. steam pressure

By HUGH J. BYRNE

Leland S. Rosener, Consulting Engineer, San Francisco, Calif.

THE PARAFFINE COMPANIES, INC., whose plant is located at Emeryville, California, on the San Francisco Bay, has recently completed the installation of a steam-electric power plant, generating power with steam at 425 lb. pressure for expansion to pressures required for various processes. It is among the very few industrials west of Chicago generating electrical energy with steam at this high a pressure.

Twenty Power Plant Studies

The capacity of the steam plant of the Paraffine Companies has recently been outgrown by the capacity of the mill To meet the increasing demand for process steam at moderate pressure, and further because of the relatively high electrical load, of which it seemed a major portion could be generated by a bleeder type turbine-generator, it was evident that a high-pressure steam power plant should be considered.

To determine the optimum power plant extension twenty different power plant studies were made of varying pressures, sizes of boilers and auxiliaries and sizes and number and fractional condensing capacities in turbine-generators. The studies were made to determine the probable net saving and net return on the investments required. The scheme chosen showed the highest net return. Details of this plan follow:

To show that the heat cost of generating electrical energy non-condensing or bleeding is extremely small, the major steps made to determine the flow of steam and water are listed in the accompanying table (Page 284) and shown on the diagrammatic heat cycle, Fig. 4. Below is given a typical example pertaining to the flow of steam and water for the condition of triple-effect operation on the power plant feed-water make-up evaporators.

Total heat of steam at 450 lb. abs., 160 deg. superheat = 1,312 B.t.u. Entropy = 1.583
Expanding adiabatically to bled pressure, total heat of steam at 165 lb. abs., 29 deg. superheat = 1,213 B.t.u. Entropy = 1.583
Heat that would be extracted by ideal Rankine engine = 99 B.t.u.
Heat extracted by actual turbine expanding to bled pressure, 99 × (0.7 = Rankine cycle ratio) = 69.3 B.t.u.
Total heat of steam after expanding to the bled pressure of 165 lb. abs = 1,312

69

Or 1,243 B.t.u.

Under this condition the bled steam would have 83 deg. superheat.
Total heat of steam at 450 lb. abs., 160 deg. superheat = 1,312 B.t.u. Entropy = 1.583
Expanding adiabatically to exhaust pressure, total heat of steam at 55 lb. abs. = 1,126 B.t.u. Entropy = 1.583
Heat that would be extracted by ideal Rankine engine = 186 B.t.u.
Heat extracted by actual turbine, expanding to exhaust pressure, 186 × (0.7 = Rankine cycle ratio) = 130.2 B.t.u.
Total heat of steam after expanding to exhaust pressure of 55 lb. abs. = 1,312

130

Or 1,182 B.t.u.

Under this condition the exhaust steam would have 12 deg. superheat.
Steam rate for that portion of steam which is bled from the turbine at 150 lb. gage, assuming a 91 per cent combined mechanical and electrical efficiency

$$= \frac{3,412}{69.3 \times 0.91} = 54.2 \text{ lb. per kw.-hr.}$$

Steam rate for that portion of steam exhausted from the turbine at 40 lb. gage $= \frac{3.412}{130.2 \times 0.91} = 28.9$ lb. per kw.-hr.

With definite process demands of the floor covering department, felt mill, refinery and roofing factory, a certain loss of condensate is determined from actual practice. These figures are given in the table. From these various steam requirements, by simple arithmetic, the steam required for the evaporators, the deaërating heater and the extraction heater may be calculated. Knowing the superheat of the bled steam and exhaust steam, the amount of water necessary for desuperheating is determinable and also indicated in the table.

It will be noted that the table does not show any water being fed to the low-pressure, or 40-lb.-gage, desuperheater. This condition is brought about by running the two boilers together and thus producing a lower initial superheat than would prevail if one boiler were carrying the entire load. The results of a study of the

flow of water and steam show that the demand for 150 lb. gage steam is 21,970 lb. and for 40-lb. steam is 53,930 lb. Using the steam rates arrived at above, the amount of power which can be generated by that steam which is extracted from the turbine at 165 lb. abs. is $\frac{21,970}{54.2}$ = 406 kw., while with that steam which is exhausted from the turbine at 55 lb. abs. it is possible to generate $\frac{53,930}{28.9}$ = 1,864 kw. Therefore with the total steam demand of 75,900 lb. per hour it is possible to generate 2,270 kw. The heat required in the fuel feed to the burners is $\frac{53,930 \times 130.2}{0.84}$ = 8,330,000 B.t.u., plus $\frac{21,970 \times 69.3}{0.84}$ = 1,810,000, or a total of 10,140,000 B.t.u. On a kilowatt-hour basis this amounts to $\frac{10,140,000}{2,270}$, or 4,450 B.t.u. per kilowatt-hour. This heat cost, assuming fuel oil of 6,000,000 B.t.u. per barrel at $1 per barrel, is 0.74 mills, which is roughly one-tenth of the cost of purchasing electrical energy of a like quantity.

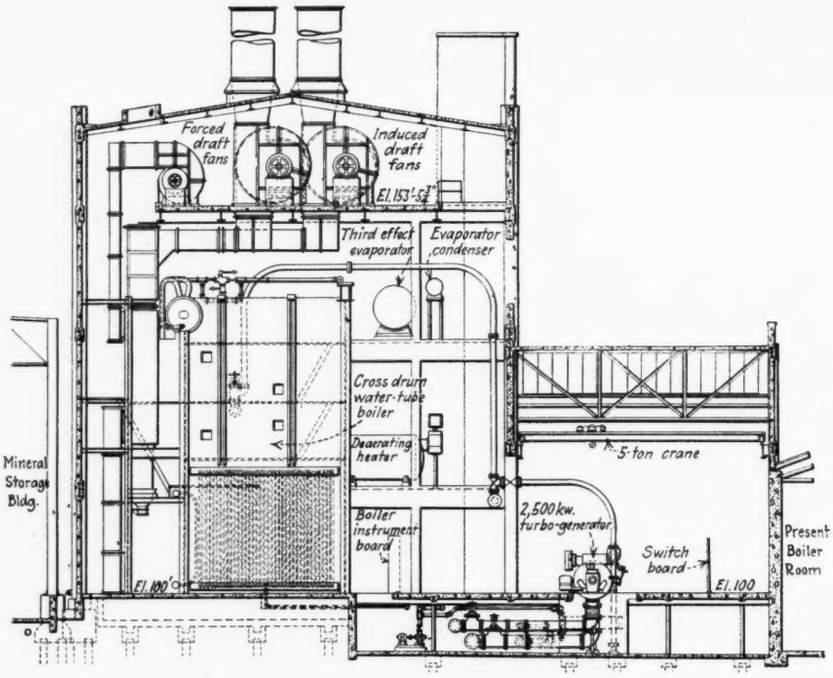

Fig. 2—Side elevation of the power plant, showing water-walled boiler furnace

It is evident from the above analysis that after making proper allowance for operating costs and interest charges, if a mill has a relatively high demand for process steam at low pressures, a modern high-pressure steam-electric plant may show a very handsome return on the necessary investment.

Boilers and Turbine in Same Room

As may be seen from the drawings and photographs, the arrangement of equipment is unique in that the equipment on the main floor section of the power plant consists of the two boilers, turbine-generator, switchboard and a motor-generator set. There are two mezzanine floors at one end of the plant, upon which are located the auxiliary equipment.

Underneath the mezzanine floors on the main floor level is the equipment requiring the closest attention, such as high-pressure water and oil pumps. On the first mezzanine floor are all of the water heaters, and on the second mezzanine floor the evaporators.

A basement is provided under the turbine-generator section forward of the boilers for the installation of several pumping sets, oil purifying and cooling system and also for the installation of large steam piping from the turbine, thereby making it possible to keep the main section of the power plant free of unsightly piping. The forced-draft fans and induced-draft fans, with stub stacks, are all mounted on a separate floor directly above the boilers.

Water-Walled Boilers

The boilers are of the wrought-steel vertical sinuous-header double-deck cross-drum type that has so thoroughly proved itself in so many high-pressure steam-electric plants. The boilers are equipped with interdeck superheaters of the loop type having a minimum of expanded joints. Saturated steam is conveyed from the boiler drum through pipes placed in the path of the hot gases between the boiler and the air preheater, into the superheater header, instead of the conventional method using saturated steam pipes outside of the boiler setting.

The boilers are set with bare tube water walls in the sides and rear extending from the furnace floor up to the first bank of the boiler tubes. The bare tubes are recessed 180 deg. into a high-grade special refractory suspended tile which is backed by four inches of insulating material and sectionalized steel panels. The front

EVAPORATION OPERATION, EFFECT

(All steam quantities in lb. per hr.)	Triple			Double			Single		
Pressure, lb. gage	40	.....	150	40	.....	150	40	.....	150
Floor covering dept.	20,000	.....	.....	20,000	.....	.....	20,000	.....	.....
Felt mill dept.	21,000	.....	.....	21,000	.....	.....	21,000	.....	.....
Refinery	.....	.....	5,000	.....	.....	5,000	.....	.....	5,000
Roofing factory	.....	.....	12,000	.....	.....	12,000	.....	.....	12,000
Total demand for process steam	.....	58,000	.....	.....	58,000	.....	.....	58,000	.....
Loss	.....	17,000	.....	.....	17,000	.....	.....	17,000	.....
Steam required in evaporators for make-up	7,050	.....	.....	9,800	.....	.....	18,700	.....	.....
Steam required in deaerating heater	5,880	.....	.....	5,620	.....	.....	6,120	.....	.....
Steam required in extraction heater	.....	.....	6,000	.....	.....	6,220	.....	.....	7,020
Total hourly steam requirement	53,930	.....	23,000	56,420	.....	23,220	65,820	.....	24,020
Less cooling water to desuperheaters	.....	.....	1,030	.....	.....	1,040	.....	.....	1,080
Steam drawn from turbine	53,930	.....	21,970	56,420	.....	22,180	65,820	.....	22,940
Total steam demand from boilers	.....	75,900	.....	.....	78,600	.....	.....	88,760	.....
Power generation possible, kw.	1,864	.....	406	1,954	.....	410	2,270	.....	424
Power generation possible, total kw.	.....	2,270	.....	.....	2,364	.....	.....	2,694	.....
Heat input to boilers, B.t.u. per hr.		74,800,000			77,300,000			87,400,000	
Fuel cost per hr. for heat, mills, (oil at $1 per bbl. of 6,000,000 B.t.u. and 84 per cent eff.)		14,800			15,300			17,350	
Additional fuel cost per hr. for additional power, mills		.....			500			2,550	
Additional power generation, kw.		.....			94			424	
Unit cost per kw.-hr. for additional power, mills		.....			5.32			6.00	

wall of the boilers and the side walls above the water walls are solid. Each boiler is equipped with six combination mechanical oil-gas burners in two rows of three each. Placing the wing burners almost four feet from the side water walls in a wide furnace, and having a relatively high and deep furnace, insures against direct impingement on the water-wall tubes and keeps the furnace heat liberation within 36,000 B.t.u. per cubic foot per hour at 500 per cent of boiler rating.

Boiler feed, steam flow, air flow, flue-gas analysis, steam and water pressures and temperatures, flue gas and air drafts, pressures and temperatures throughout the path of air and flue gas flow are indicated or recorded, or both, by instruments mounted on separate boiler panels, enabling the operators to keep a thorough check on their boiler operation from a central point. Fuel and fan control apparatus are mounted on the same boiler panels.

After an exhaustive study of fixed charges, operating costs and maintenance, the following scheme was adopted for handling flue gas and air supporting combustion. The induced- and forced-draft fans each have a direct connected 30-hp. constant speed motor which will enable loads to be carried as high as 275 per cent of boiler rating, with intermediate loads controlled by dampering directly from the boiler panels. The forced-draft damper is manually controlled, while the induced-draft damper is electrically driven. Both dampers are provided with position indicators at the boiler panels.

Loads above 275 per cent of rating will be carried by the 150-hp. variable-speed motors on each of the induced- and forced-draft fans mounted on the same shaft as the 30-hp. constant-speed motors. These large variable-speed motors pick up the load from the small motors at half of the former's full-load speed. Eleven points of speed control are provided for the variable-speed motor to effect proper operating conditions with minimum power requirement. If at any time the power supply to the induced- or forced-draft fans is ruptured, solenoid-operated trip stop valves in the main oil lines to the boilers will be automatically closed immediately, preventing damage to the boiler settings.

Power Interchange With Automatic Balance

The operation of the turbine-generator is fully automatic. From a steam-distribution standpoint the turbine is set in parallel with a system of reducing valves. The generator is electrically connected in parallel with an outside source of purchased power. With the generator so connected the amount of power that it generates will be governed by the amount of exhaust and bled steam that is drawn from the turbine and it will at times of high process steam demand and low process electrical demand pump power into the outside source. If, however, the turbine-generator is isolated or operated in

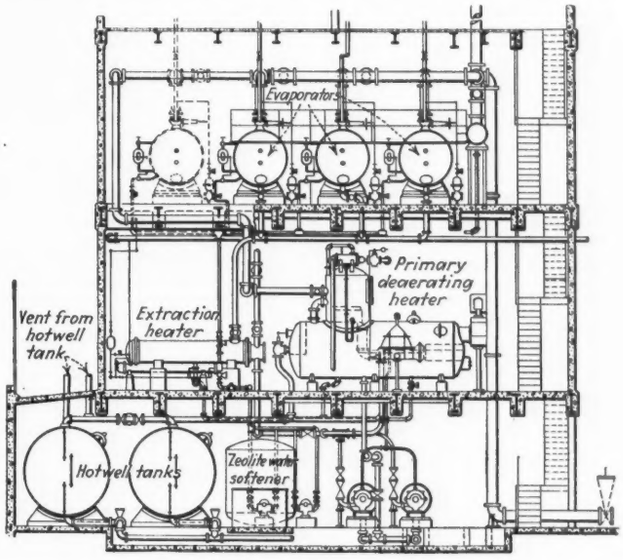

Fig. 3 — Elevation, showing power plant auxiliaries on three levels

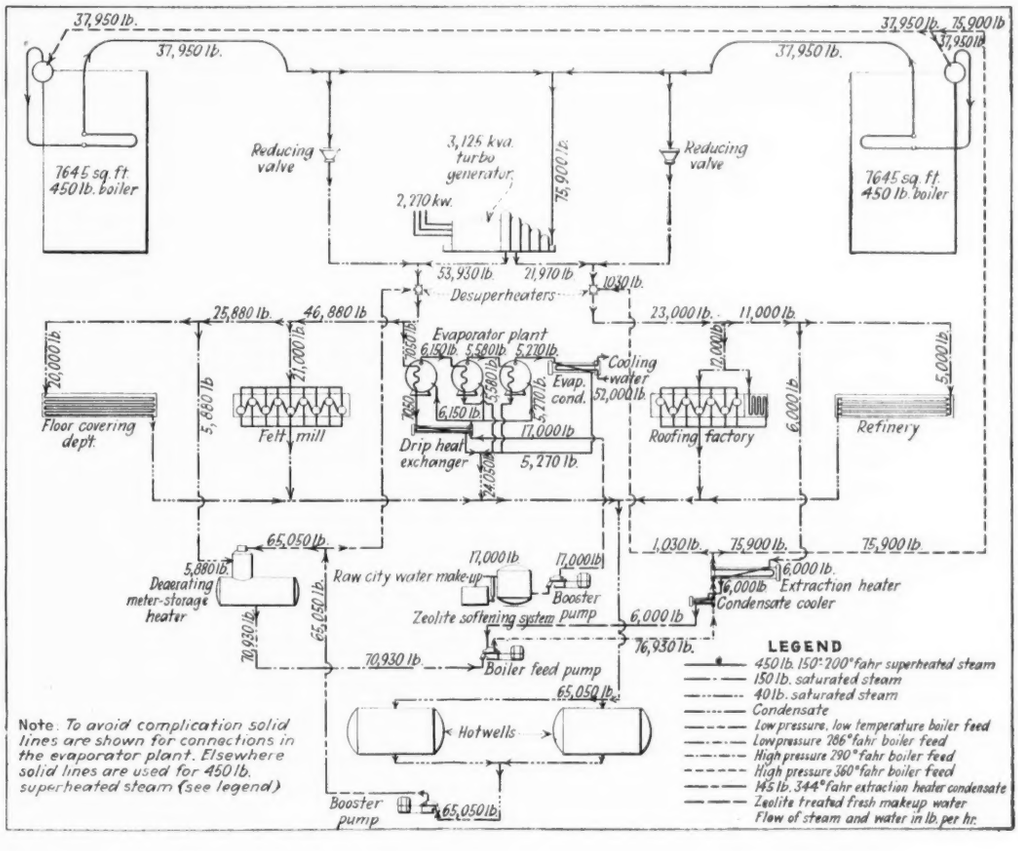

Fig. 4—Flow diagram, showing division of exhaust steam between process and evaporators

parallel with another like machine, as it may be in the future, it will be found upon referring to Fig. 4 (the diagrammatic heat cycle) that reducing valves would expand high-pressure steam into the 40-lb. and 150-lb. systems to maintain constant pressure whenever the electrical load of the turbine decreased. A decreasing electrical load will tend to diminish the pressure in either the 40-lb. or 150-lb. process lines.

As an example, consider what would happen if the process demand for 40-lb. steam increased. Increasing the demand for 40-lb. steam would tend to drop the pressure in the 40-lb. system, into which the turbine exhausts. If the turbine can carry more electrical load, then additional steam would automatically be taken by the turbine and exhausted to maintain a constant exhaust pressure of 40 lb. If, however, the turbine cannot carry an additional electrical load because of the electrical load demand not at the same time increasing, then the reducing valve will automatically reduce high-pressure steam into the 40-lb. system and build the pressure up and hold it constant. The same procedure automatically maintains a constant pressure of 150 lb. in the other process line into which the turbine discharges bled steam. For decreasing steam demands the reverse procedure holds.

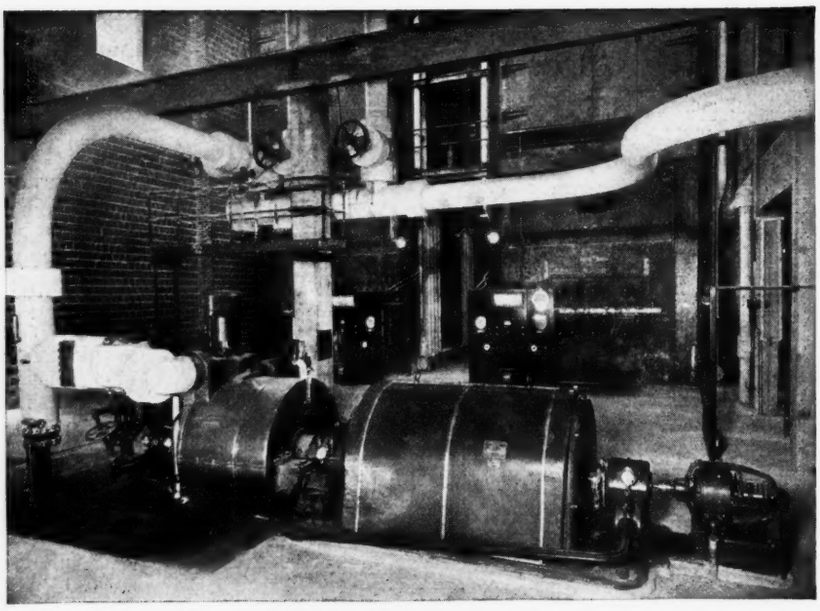

Fig. 5—Following a recent central station trend, no wall separates turbine and boilers

The best system for providing pure boiler feed make-up brought about much discussion and investigation, which resulted in adoption of the following plan. The make-up water is first treated by zeolites. The zeolite-treated water is forced by city pressure, or booster pumps if necessary, into the evaporator shells, where steam is generated and condensed, thence flowing to hot wells. A concentration not to exceed 75 to 100 grains per gallon will be maintained in the evaporator shells. A certain amount of carryover from the evaporators is anticipated, which will necessitate after-treatment in the boilers individually to maintain a certain total concentration, hydroxyl alkalinity, carbonate alkalinity, chloride content, phosphate content, and ratio of sulphates to carbonates, all of which are necessary to prevent scaling, priming, caustic embrittlement and corrosion of the boilers.

Evaporators Used to Vary Steam Demands

The power plant evaporators have been made to serve a twofold purpose. Their purpose is, primarily, to provide pure boiler feed make-up, and, secondarily, to serve as equivalent fractional condensing capacity on the turbine by making it possible to effect a variable demand for 40-lb. steam exhausted from the turbine. The variable demand for 40-lb. steam is effected by the method of evaporator operation, namely, triple-effect, double-effect or single-effect. The rate of providing boiler feed make-up may be controlled from any floor level by a chain-operated valve in the steam line to the evaporator condenser on the second mezzanine floor.

In selecting evaporators for providing the necessary pure water for boiler-feed make-up in line with the general layout, considerable stress was given to continuity of operation. Therefore it was originally specified that the capacity of any two evaporator shells operating in series be the same as that for triple-effect operation. Observing that with double-effect evaporator operation more steam is required than with triple-effect operation, it was evident that it was possible to generate more power with the added demand for exhaust steam. Complete analysis showed that the additional power thereby gained could be generated at a lower cost than it could be purchased from an outside source.

Realizing that the evaporators could be used as equivalent condensing capacity on the turbine, it was later specified that any two evaporator shells in parallel should produce the same maximum quantity of make-up water as under triple-effect operation. This arrangement makes it possible to generate power economically when the mill electrical load is high, operating the power plant evaporators single-effect or double-effect. The operation is changed to triple-effect when the electrical load falls off, always bearing in mind that, from the standpoint of evaporator plant economy, the greatest efficiency is attained with increasing number of units in series.

The table for double- and single-effect power plant evaporator operation shows that the unit cost per kilowatt-hour of the additional power generated by changing from triple- to double- or single-effect is 5.32 mills per kilowatt-hour and 6.00 mills per kilowatt-hour, respectively. In addition to having the required make-up water capacity in the evaporating plant, the equivalent turbine condensing capacity mentioned above has been provided, though no condensing equipment has been bought for the turbine.

One of the novel features of the plant is the means of conserving the energy contained in the extraction-heater condensate. Very often extraction-heater condensate is allowed to blow either directly into the hot-well or into a direct-contact heater. When high-pressure, high-temperature condensate is allowed to drop to a lower pressure a certain amount of flash occurs, and if this flash, or steam, is condensed the heat may be saved, although a considerable amount of "heat head" or availability is lost.

After considerable thought, it was decided to pump this extraction-heater condensate into the boiler-feed

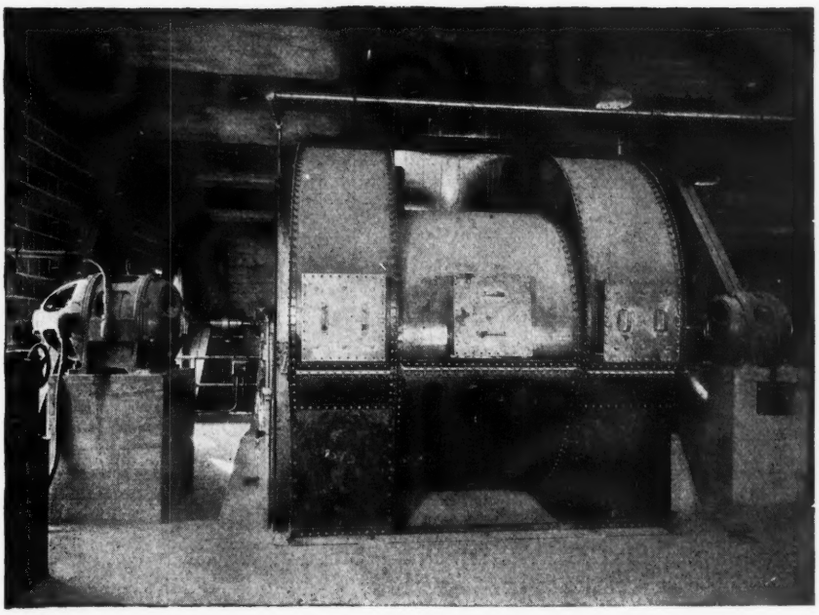

Fig. 6—Induced-draft fan has dual motor drive, 150-hp. (left) and 30-hp. (right)

pumps between the second and third stages, where the pressure would be about 215 lb. gage. This, however, would necessitate the installation of two pumps between the extraction-heater drainer and the boiler-feed pumps. Using such interstage pumps would entail another continuous operating expense with additional complication.

The natural evolution was, therefore, to eliminate the interstage pumps and substitute a condensate cooler, so that the outcome resulted in passing the extraction-heater condensate from the drainer through a condensate cooler and thence into the boiler-feed pumps between the first and second stages, where it mixes with the main boiler-feed supply at a pressure of about 130 lb. gage. This condensate is cooled by the main boiler feed in the condensate cooler to a point where it will not flash at the pressure prevailing between the first and second stages of the boiler-feed pumps. All of this is shown in the diagrammatic heat cycle. The amount of availability saved at full load on the plant is equivalent to pumping water into a 3,000-sq.ft., 150-lb. boiler, and provides an easy means of eliminating what might otherwise be a nuisance.

Throughout the plant it was endeavored to install equipment as nearly "foolproof" and automatic in its operation as possible, after giving proper consideration to all charges and continuity of operation. Valuable corroborative data will be available in the near future.

Power Equipment in Plant of the Paraffine Companies, Inc.

Boilers, Furnaces and Equipment

Two boilers, cross-drum, 450 lb. press., 7,645 sq.ft., Babcock & Wilcox Co.
Water walls, bare tubes recessed in refractory blocks, Babcock & Wilcox Co.
Refractory design and materials.....M. H. Detrick Co., Vitrefrax Corporation, Gladding-McBean & Co.
Superheaters interdeck loop.....Babcock & Wilcox
Air preheaters, Thermix, 12,221 sq.ft...Prat-Daniel Corp.
Soot blowers .....Diamond Power Specialty Corp.
Feed-water regulators, Copes....Northern Equipment Co.
Insulating materials...Plant Rubber and Asbestos Works
All above equipment installed by..C. C. Moore & Co., Engrs.
Subcontractor on refractories.....J. T. Thorpe & Son

Turbine-Generator

One, 2,500-kw., aut. extraction, non-cond., 3,600 r.p.m., 2,400 volts, 60 cycles, 3 phases....General Electric Co.
Throttle pressure, lb. gage.....425
Bleed and exhaust press. lb. gage.....150 and 40
Switchboard.....Westinghouse Elec. & Mfg. Co.

Draft Fans

Type, Turbovane, manufacturer.....B. F. Sturtevant Co.
Forced draft, air per hr. at 100 deg.@15 in., lb. ...167,000
Induced draft, air per hr. at 407 deg.@9 in., lb...176,000

Heaters

Primary feed-water heater; combination heating, deaërating, metering and storage.....Cochrane Corp.
Installed by .....C. C. Moore & Co. Engrs.
Extraction heater, closed.....Elliott Co.
Extraction heater condensate-cooler.....Elliott Co.
Power plant make-up evaporators..Foster Wheeler Corp.
Capacity, lb. per hr., with 40 lb. gage pressure steam at first effect coil.
As triple-effect 30,000
As double-effect, any two shells in series..30,000
As single-effect, any two shells in parallel..30,000
Installation by .....C. C. Moore & Co. Engrs.

Fuel Oil Pumping and Heating Set

First-stage pumps, motor-driven rotary..Viking Pump Co.
Second-stage pumps, motor-driven rotary, Northern Rotary Pump Co.
Oil heaters, closed, tubular.....Griscom-Russell Co.

Turbine Oil Purifying System

Type, centrifugal De Laval-Funk process, De Laval Pacific Co.
Capacity, gal. per hr.....30

Reducing Valve and Desuperheater Systems

Reducing valves .....Atwood & Morrill Co.
Desuperheaters .....Elliott Co.
Water control governors for desup.....Bailey Meter Co.

Water Pumps

All are Cameron motor-driven.....Ingersoll-Rand Co.
Zeolite-treated evaporator make-up, single-stage, 35-lb. head, 1,750 r.p.m., gal. per min.....60
Deaërating-heater booster pumps, single-stage, 70-lb. head, 1,750 r.p.m., g.p.m.....240
Boiler-feed pumps, six-stage, 500-lb. head, 1,750 r.p.m., g.p.m. 240
Generator air cooler, salt-water pumps, single stage, 21-lb. head, 1,750 r.p.m., g.p.m.....250

Motors

All motors by.....Westinghouse Elec. & Mfg. Co.
For each forced-draft fan, one constant-speed 870-r.p.m., b.hp. 30
And one variable-speed, 1,750-r.p.m., b.hp.....150
For each induced-draft fan, one constant-speed, 435-r.p.m., b.hp. 30
And one variable-speed, 870-r.p.m., b.hp.....150
For each zeolite-treated make-up water pump, one constant-speed, 1,750-r.p.m., b.hp.....5
For each deaërating heater booster pump, one constant-speed, 1,750-r.p.m., b.hp.....20
For each boiler-feed pump, one constant-speed, 1,750-r.p.m., b.hp. 150
For each generator air cooler pump, one constant-speed, 1,750-r.p.m., b.hp. 7½
For each first stage oil pump, one constant-speed, 1,200-r.p.m., b.hp. 3
For each second-stage oil pump, one constant-speed, 1,200-r.p.m., b.hp. 7½

Meters and Instruments

(One complete set for each boiler.)

Steam and feed-water meters.....Bailey Meter Co.
Recording pyrometers .....Wilson Maeulen Co.
Draft and pressure multi-pointed gages.....Hays Corp.
Continuous flue gas recorders....C. J. Tagliabue Mfg. Co.
Thermometers, Tag-Hespe.....C. J. Tagliabue Mfg. Co.
Pressure gages, Navy specification...Jas. P. Marsh & Co.

Piping, Valves and Fittings

Valves by.....Wm. Powell Co., Atwood & Morrill Co., Lunkenheimer Co., Consolidated Ashcroft Hancock Co., Crane Co.
Piping by....Crane Co., Midwest Piping & Supply Co., Turner Co.
Fittings by .....Crane Co., Walworth Co.

Diffusion as a Factor In Burning Pulverized Coal

By DOUGLAS HENDERSON

Vice-President
Fuel Engineering Company of New York

Gases mix by diffusion, that is, by automatic molecular movements. But the laws of gaseous diffusion do not apply to fine, solid particles. Thus, while the volatile constituent of pulverized coal burns as a gas, the coke particles follow other laws. This distinction is fundamental in attacking the problem of carbon loss in stack gases

AMERICAN bituminous coals vary in gaseous or volatile content from about 15 per cent. to the neighborhood of 40 per cent, with the solid matter ranging from 50 to 80 per cent. For example, a coal containing 30 per cent volatile matter will derive about two-thirds of its heat from the solid carbon and only the remainder from the volatile matter. It is important, therefore, that complete combustion of the solid matter, as well as the gaseous, be effected in order to develop the maximum heat from the fuel.

When coal is fed into a furnace it is first distilled, giving off gaseous hydrocarbons, carbon monoxide and hydrogen, and leaving behind a residue of solid carbon known as coke. It is a two-stage process; first, the breaking up of the complex fuel into its elementary parts; and, secondly, the combustion of these elementary fuels. These elementary fuels are gases and solids, and the laws governing the combustion of the two states of matter are quite different.

Gases Burn by Diffusion

GASEOUS FUELS may be burned with relative ease, for very definite reasons. The combustion of a gas is dependent only upon its being properly mixed with oxygen, which, of course, is supplied, in actual practice, by air. The mixing of air with a gaseous fuel proceeds according to the laws of *diffusion*. This is the name given to the long-established principle that two different gases mix with great rapidity when in contact with each other. Hence, air, which is a gas, will quickly mix with a combustible gas in a very intimate manner.

This mixing results automatically from the natural movements of the molecules. At all temperatures above absolute zero gas molecules are in constant rapid motion, each molecule traveling freely in one direction until a collision changes its course. Thus air, without any outside assistance, will rapidly form an intimate molecular mixture with the gases evolved from the volatile constituents of coal particles.

True Flame and False

WHEN a proper mixture of combustible gas and air is brought to the ignition temperature a phenomenon occurs which is called a *flame*, and the combination of the two gases is accompanied with the evolution of heat, sometimes light. It cannot be emphasized too strongly that flame is the result of *gaseous* combustion. This caution is necessary because of the frequent occurrence of a false "flame," which is in reality composed of fine particles of red hot coke suspended in, and swept along by, a current of hot gas. On close inspection the true nature of such a "flame" is apparent. If incandescent carbon particles are present in a true gaseous flame they are of molecular size and not individually visible to the eye.

The ignition temperature of any fuel is the lowest temperature at which combustion becomes self-propellent. With gaseous fuels this temperature is considerably lower than the ignition temperature of solid carbon. Thus, with coal, the combustion of the gaseous content occurs with little difficulty, taking advantage of the natural laws that work in its favor. The burning of the solid carbon presents the real problem.

From the time when serious thought was first given to the principles of combustion until the present, three theories regarding the combustion of solid carbon have been advanced. The first of these was that solid carbon, when burned, produced carbon dioxide as the first product. Further study of combustion revealed that this

hypothesis was not entirely satisfactory; and Sir Lowthian Bell developed the second theory, which held that carbon monoxide was the first product of the combustion of solid carbon, and that carbon dioxide was the result of subsequent combustion of the carbon monoxide with oxygen. Other experimenters produced evidence to support this view.

Finally, however, after contradictions appeared which tended to nullify both of these beliefs, a third and more generally accepted theory was evolved. In this it is held that a complex compound of carbon and oxygen is formed when solid carbon is burned, and this complex compound further breaks down to both carbon dioxide and carbon monoxide, the relative amounts being determined by the temperature.

According to this theory, oxygen from the air, on uniting with hot carbon, forms carbon dioxide, some carbon monoxide, and a physico-chemical compound that has been designated C_xO_y, which, in turn, breaks down to form carbon dioxide and carbon monoxide. The carbon dioxide will be reduced, or the carbon monoxide burned to carbon dioxide as a secondary reaction, depending on the time of contact, the temperature, and whether there is an excess of carbon or an excess of oxygen.

Coke Cannot Diffuse

WHETHER or not this theory is correct, the known important requirements in burning solid matter are (1) that the carbon remain in the furnace at its ignition temperature until burned, and (2) that air with its oxygen supply be moved relatively to the particles of solid carbon to effect their complete oxidation. The second requirement follows from the fact that the solid particle cannot "diffuse."

The ignition temperature of the solid carbon is higher than that of the gaseous hydrocarbons which are distilled when the coal enters a hot furnace. The range of the latter is from 960 deg. F. for ethane, to 1,200 deg. for methane. Clement and Scholl[1] found that the ignition temperature of bituminous coal dust was 1,472 deg. and higher. Anthracite has a higher ignition temperature than coal that contains a larger proportion of volatile matter. Coke, which is the result of subjecting bituminous coal to the heat of the furnace, dispelling the volatile matter, has a substantially higher ignition temperature than the gases originally in the coal. Here is the reason for the importance of time of contact and temperature in the combustion of solid carbon. There is just one system of combustion that limits the time of the solid carbon in the furnace and that is pulverized coal. The use of this method calls for a careful consideration of these principles that govern the burning of solid carbon.

The principle of diffusion, so valuable in gaseous combustion, does not offer any aid in burning solid carbon. A publication of the Bureau of Mines[2] clearly points out the necessity for thoroughly agitating the mixture of coal and air by showing that coal requires about 10,000 times its own volume of air at atmospheric temperature to completely burn it. If a particle of coal were to enter a furnace in a sphere of air at ordinary temperature just large enough for complete combustion of the particle, this sphere of air would have a diameter 20 times that of the coal particle.

This same bulletin points out that the particles of coal as they pass through the furnace are probably continuously gasified, not only by the oxygen, but also by the carbon dioxide, and to a lesser extent by steam. The carbon monoxide and hydrogen formed are again converted into carbon dioxide and steam by the air entering the front ports of the furnace.

What happens in practice is that the individual particle is in an atmosphere composed of carbon monoxide, carbon dioxide, hydrogen, steam and air in varying proportions. It is giving off carbon monoxide and carbon dioxide at its surface and decreasing in size. As this takes place, the mass of gas surrounding the particle becomes greater in proportion to the mass of the particle, and to a larger extent the particle is bombarded with the molecules of gas which do not support combustion, and, as a result, the smaller the particle becomes the slower it burns. Thus the length of time the particle remains in the combustion chamber again becomes an important factor, and at the same time the necessity of vigorously moving the coal particle and air supply with relation to each other becomes evident.

Practically all of the carbon monoxide formed at the surface of the coal is burned, and the heat loss due to carbon monoxide is negligible compared to the loss due to solid carbon escaping in the flue gas. This proves that it is more difficult to bring oxidizing gases into continuous contact with solid particles than to bring the carbon monoxide into intimate association with oxygen.

A publication of the National Electric Light Association[3] has presented some interesting practical evidence of this difficulty in the case of pulverized coal. The following statement was made regarding the presence of combustible matter in the stack gases, based on data submitted by member corporations:

"The combustible in the fly-ash varies from 1 per cent to 35 per cent, with one plant reporting 49 per cent for bituminous coal. This figure varies from 10 per cent to 50 per cent for plants using anthracite coal. Forty to eighty per cent is reported for petroleum coke."

It is expected that the results in the central station field will be substantially better than those obtained in industrial boiler plants, and yet the combustible contents reported represent considerable losses.

Problem of Unburned Carbon

IT MUST never be forgotten that reduction of coal by pulverization to a condition in which it apparently obeys the mechanics of gases will not make it burn like gas. Five years ago the statement was made in a Bulletin of the Bureau of Mines[4] that "unfortunately, the combustion of powdered coal has been confused with the combustion of gas," and it begins to appear in the light of subsequent experimental data that the statement was peculiarly prophetic. Pulverized coal has resulted in better combustion of the gaseous content of coal, but the combustion of the solid carbon is handicapped by the physical requirements already referred to and as evidenced by unburned particles in the flue gases.

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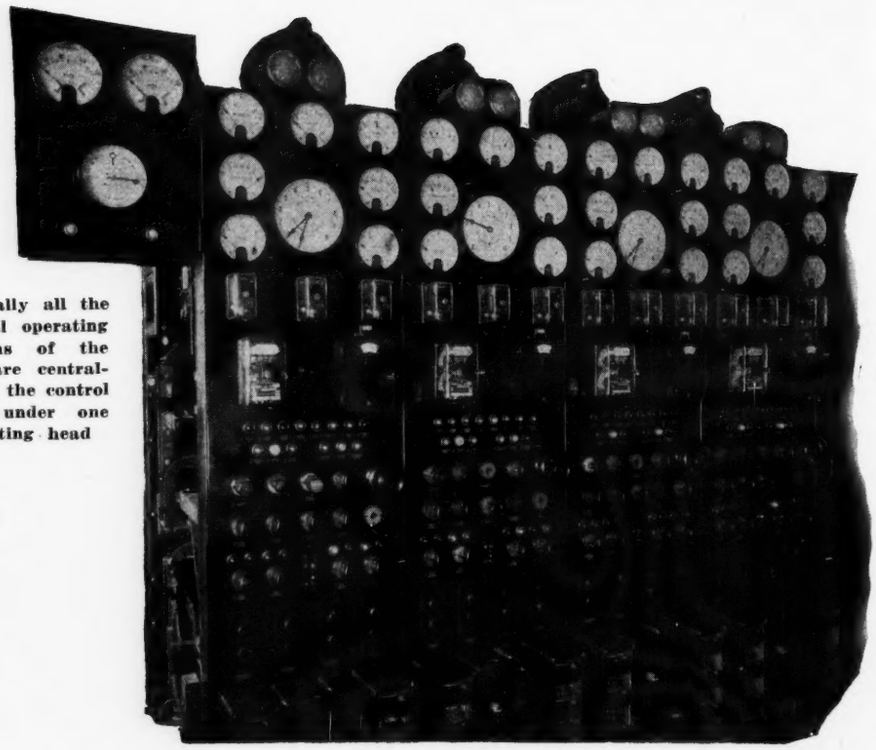
[1]Bulletin 102, United States Bureau of Mines.

[2]Bulletin 223.

[3]Report of Prime Movers Committee, Engineering National Section, "Pulverized Fuel," December, 1929.

[4]Bulletin 237.



Practically all the essential operating functions of the plant are centralized on the control board under one operating head

Convenient Operation Featured in Saluda Design

Saluda hydro-electric development of the Lexington Water Power Company has four 55,650-hp. 180-ft. head units. By an extensive system of remote control and signal devices practically the entire operation of the plant is centralized under one operating head, thus eliminating mistakes due to telephone orders

By O. L. HOOPER and J. P. GARVIN

Engineering Department
W. S. Barstow & Company, Inc.

THE SALUDA development of the Lexington Water Power Company, subsidiary of the Associated Gas & Electric Company, is on the Saluda River, nine miles above its junction with the Broad River at Columbia, S. C. An earth dam 7,838 ft. long and with a crest of 208 ft. above the river's bed forms a reservoir having an area of 78 sq.mi. and containing 102 billion cubic feet of water. The normal draft on the reservoir represents a storage that will generate 200 million kilowatt-hours. During extreme dry periods it may be necessary to draw down 60 ft., which would allow generating an additional 40 million kilowatt-hours.

Four 16-ft. diameter plate-steel conduits incased in concrete and a 48-ft. semi-circular reinforced concrete arch pass through the dam. At the upper ends of these are the intake towers, with rack, gates and other equipment for control of the water. Four steel conduits, resting on rock foundation in the river's bed, serve to conduct the water to the four turbines now installed. Two additional steel conduits for the future units may be erected in the arch conduit.

At the downstream end of each conduit is a 16x16x14 ft. plate-steel tee to make connection with the external riser of a differential surge tank. At present, surge tanks are installed on Units 1 and 3 only. It is intended that these units will do all regulating with fast governing, and Units 2 and 4, with slow governing, will run at practically constant load. The tees for Units 2 and 4 are the same as for the other two except that the 16-ft. pipe has a complete shell plate at the tee. If surge tanks are added the shell plate at the tee may be cut out on the inside of the riser.

Tailrace conditions were such as to fix the elevation of the center line of waterwheels 18 ft. above the center line of the conduits under the dam. The penstocks from the surge tanks into the power house have a reverse curve in elevation. They are inclosed in reinforced concrete that serves to anchor the bend.

In each penstock, just outside the power house, is a 16-ft. butterfly valve. These valves are motor-operated, with the motor and gearing inside the power house. The guides for the crossheads are embedded in the power house wall, and the operating levers and connecting rods are outside the wall. Each valve has a 24-in. bypass pipe and motor-operated valve, which is used to equalize the pressure on the butterfly valve disk before it is opened.

Four Francis turbines are installed, with space for two future units. These wheels are rated 55,650 hp. at full

gate and 180 ft. head and operate at 138.5 r.p.m. Plate-steel scroll cases are used, and the draft tubes are of the elbow type with a long horizontal discharge. Each generator is rated 40,625 kva. at 0.8 power factor, is wound for 13,800 volts, 3 phases, 60 cycles, and is equipped with a 250-kw. direct-connected exciter and a 35-kw. pilot exciter. The generators are of the single-bearing, overhung-rotor type, having a thrust and steady bearing in the same oil pot beneath the rotor. The construction allows the rotor to be removed and gives access to the windings without disturbing the thrust bearing. It also keeps all oil beneath the rotor and prevents leaking oil being thrown into the windings.

The 40,000-kva. transformers are on the downstream platform of the power house. They are mounted on tracks that allow moving them into the power house. A lifting rig is provided so that a transformer can be lifted

Fig. 1—The generators are rated at 40,625 kva., 0.80 power factor, and have a 250-kw. direct-connected exciter and a 35-kw. pilot exciter

over the generator bracket when it is necessary to carry it to the working bay.

Provision has been made for testing the units by the Allen salt-velocity method. The salt will be introduced through a pipe temporarily installed in the air vent at the intake, with the operating table and salt tanks located on one of the floors near the top of the tower. Electrodes will be installed between the butterfly valves and the scroll case. Four piezometer taps near the entrance to the scroll case are connected into a header which is carried to the control room, where a mercury-column pressure gage records the pressure head at the entrance to the turbine and allows determining the losses in the penstock, as well as the head on the unit.

In addition to the piezometer at the scroll-case entrance, taps are provided for measuring the flow through the units in accordance with the Winter patents. These taps are piped to the turbine floor, where a recording, or non-recording, manometer can be connected. The manometer will measure the difference in pressure between a tap on the periphery of the scroll case and one near the speed ring. By calibrating the readings on these piezometer taps, during the salt-velocity tests, the flow through the unit may be determined under any conditions of gate opening or head and a check on the efficiency of the units may be made.

In one of the intake towers is a recording gage of the float type with Selsyn motors for remote indication of the head-water level. There is also a similar gage in the tailrace of the plant. The remote indicators are in the power house control room.

For each unit there is an actuator and a main oil-pressure tank for each two actuators. In addition, an auxiliary or reserve pressure tank for each two actuators is provided as a substitute for hand control of the gates and is supplied from the pressure line through a check valve. There are two oil pumps for each group of two units, each pump sufficiently large to supply both units under normal conditions. One pump of each pair will be operated as a preference pump. Its unloader valve is set by hand at a higher starting pressure than that of the other pump, and its electrical switch is shunted so that the motor runs continuously. The non-preference pump will operate only in case the accumulator tank pressure drops abnormally low. When the units are shut down the shunt on the switch will be open, so that the preference pump will run intermittently to keep the oil pressure in the tanks normal. A drum switch is mounted near each pair of pumps to make the proper electrical connections between the switchboard and whichever pump is selected for preference operation.

The governor is equipped with a flyball motor driven from the pilot exciter, an emergency safety solenoid, a speed-changing motor, a load-limit motor, a Selsyn motor for gate-opening indication, a Selsyn motor for gate-limit indication and a flyball signal switch.

Turbine Bearings Oil-Lubricated

The turbine bearings are oil-lubricated. Each unit has a belt-driven oil pump used while the machine is running and a motor-driven pump for starting the unit or in case the belt breaks.

Since two of the units operate without surge tanks, it is necessary to regulate the rate of closure of the turbine gates so that there will not be an excessive pressure rise in the penstocks. For maximum assurance against tampering, this is accomplished by a diaphragm and orifice in one port of each servomotor.

Control of essential hydraulic and electric equipment is located in a control room that is part of the power house building. The head gates, butterfly valves, bypass valves, bearing lubricating systems, governor systems and air-braking systems are controlled and the condition of equipment indicated on switchboards in this control room. Adjacent to these switchboards are those for control of the generators, main station service circuits and transmission substation. This arrangement places the operator within easy reach of the station's essential control, leaving the floor man free to inspect, adjust and lubricate auxiliary equipment.

The headgates are controlled over a multi-conductor cable approximately 2,200 ft. long. The gates may be

raised or lowered from push buttons on a board in the control room. The position of the gate in the tower is shown at all times by gate indicators located on this board.

Butterfly valves with bypass valves at the entrance to the turbine scroll case are operated by direct-current motors and suitable geared mechanisms. These motors obtain power from a storage battery located in the power house below the control room. The valves can be locally controlled at the equipment or remotely controlled from push buttons on the control panel of the generator which they serve. One double-button control station on the generator panel serves to open or close both the bypass and butterfly valves. The sequence of operations on the opening cycle allows the bypass valve to open first, and when pressure is normal in the turbine casing a pressure-regulator contact is made, which then allows the butterfly valve to be opened. Both valves are closed simultaneously from the remote-control point. The open position of the butterfly valve is indicated on the generator panel by a green light.

Before starting a unit the motor-operated auxiliary lubricating-oil pump is started from the generator panel. This pump is automatically stopped as soon as the shaft-driven pump attains sufficient speed to supply oil to the bearing housing. Four green lamps indicate that the temperature of the turbine and generator bearings is normal, that oil is at the proper level and that the shaft-driven pump is operating. Should any of these functions become abnormal during the unit's operation, the lamp indicating that function will be extinguished and at the same time an alarm signal will be sounded. This alarm is connected in parallel with a conspicuous white lamp that is lighted simultaneously with the sounding of the alarm, thus indicating visually which unit is in trouble. Should the shaft-driven pump fail, the motor-driven pump will automatically start if the unit is operating, so that, even though the trouble signal is sounding, the unit is still in condition to run in so far as lubrication is concerned.

A two-button push-button station on each generator panel bypasses the contact on the unloader valve of the

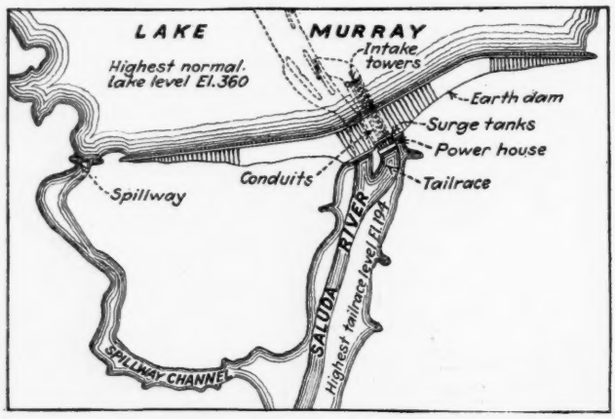


Fig. 2—General plan of the development, with the earth dam 7,838 ft. long

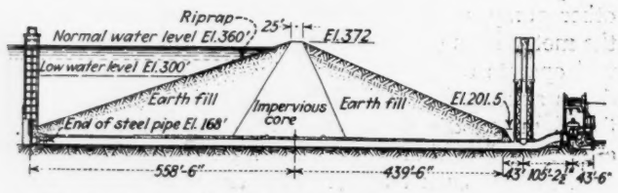


Fig. 3—Cross-section through the earth dam at the power house and intake towers

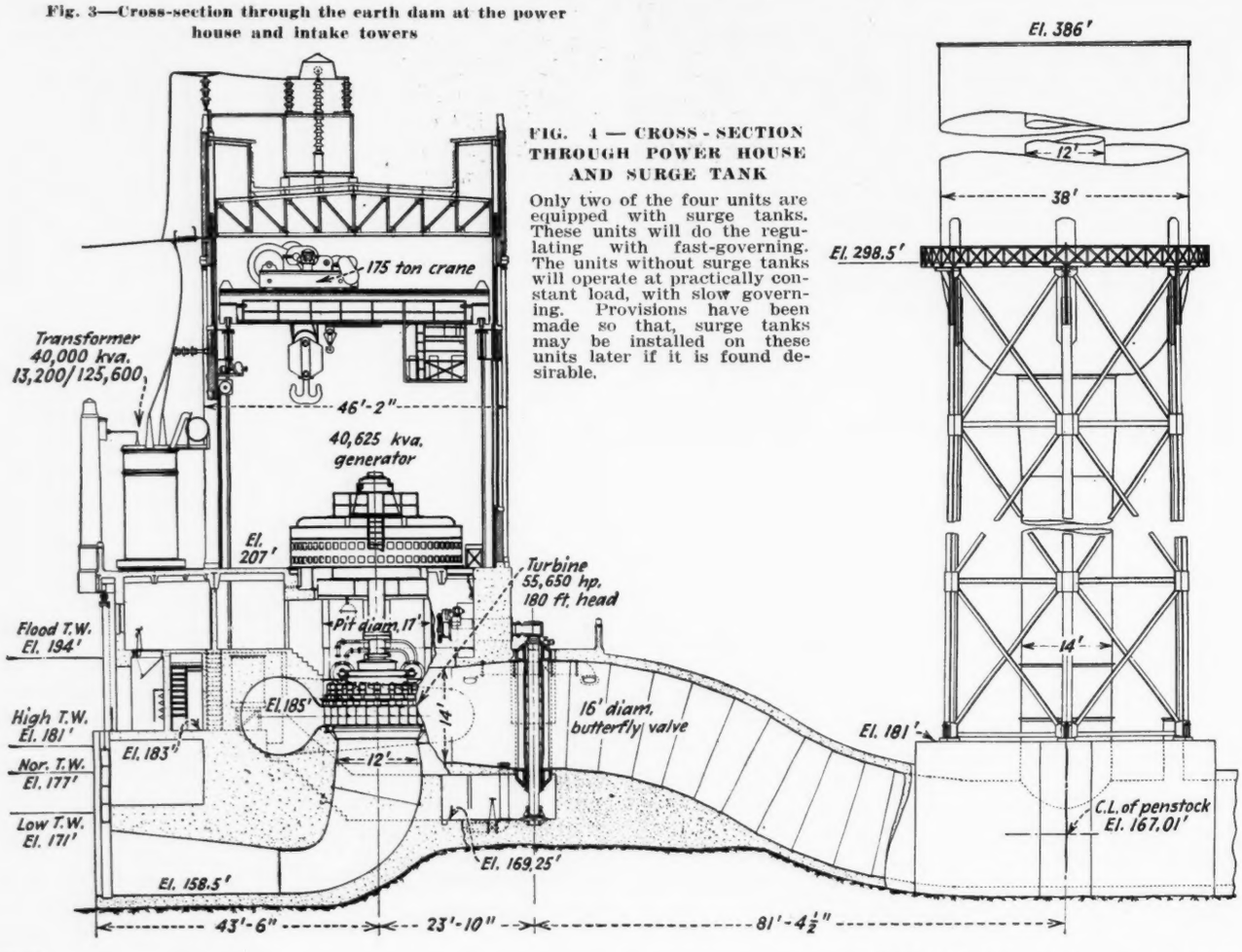


FIG. 4 — CROSS-SECTION THROUGH POWER HOUSE AND SURGE TANK

Only two of the four units are equipped with surge tanks. These units will do the regulating with fast-governing. The units without surge tanks will operate at practically constant load, with slow governing. Provisions have been made so that, surge tanks may be installed on these units later if it is found desirable.

preference governor-oil pumps. Since one preference pump and one non-preference pump serve two units, the two push buttons on these two generator panels are connected in parallel, as well as the indicating lights.

A green lamp on each generator board is energized whenever the foot valve of the preference governor pump is lifted, thus indicating that the equipment is operating. A white light is also energized whenever the foot valve of the non-preference pump is raised. By these indications the operator is advised at all times of the operating condition of the governor pumps. A second green light indicates normal oil pressure in the accumulator tank.

Indication of the governor and gate mechanisms' position is given on the generator panels and is accomplished by Selsyn indicators. A white light energized through a special commutator on the generator shaft indicates the rate of acceleration or retardation of the unit during starting and stopping operation. This flicker device indicates to the operator the proper time to apply the air brakes when shutting down the unit. The brakes cannot be applied, however, until the governor closes the gates. In case of internal generator trouble the governor automatically closes the gates, and the brakes are set. A green light indicates that the generator air brakes are released, and another green lamp indicates that the governor safety solenoid is energized.

Failure of the cooling water to the generator's thrust bearings and to the power transformers, also excess temperature of the main power transformers, are indicated by the extinguishing of green lights on the control panel.

A master drum switch on the panel for each generator will disconnect the mechanical trouble alarm circuit when in the off position. In this position the unit can be started, but no load can be taken on until this drum switch is put in the run position. When in the run position, the mechanical trouble alarm and white indicating lights will be energized if any of the green indicating lamps are extinguished for any reason whatever. The operator can quickly ascertain which unit and which function are in trouble. It is left to his judgment to determine whether the unit must be shut down or whether minor repairs can be made to keep the machine running.

The high-tension substation, although nearly 1,000 ft. away from the power house, is also controlled and metered on the panelboards in the power house control room; but the protective relays for the transmission lines are on switchboards in a relay house at the substation. The operator is advised of the abnormal operation of this equipment, also the general type of trouble that caused abnormal operation of circuit equipment, by means of special signaling devices energized over a multi-conductor telephone cable. This substation can also be locally controlled at the relay house.

The main station service circuits and equipment are also controlled, indicated and metered on panelboards located in the control room. This gives the operator control not only of the main power flow but also of the loading of the station service transformer bank equipment. He can shift the station service load at the same time that units are changed.

With this type of control entire operation of the plant, in so far as the essential functions are concerned, is centralized under one operating head, thus to a very large extent eliminating the misunderstanding and mistakes that are possible when orders are given over the telephone.

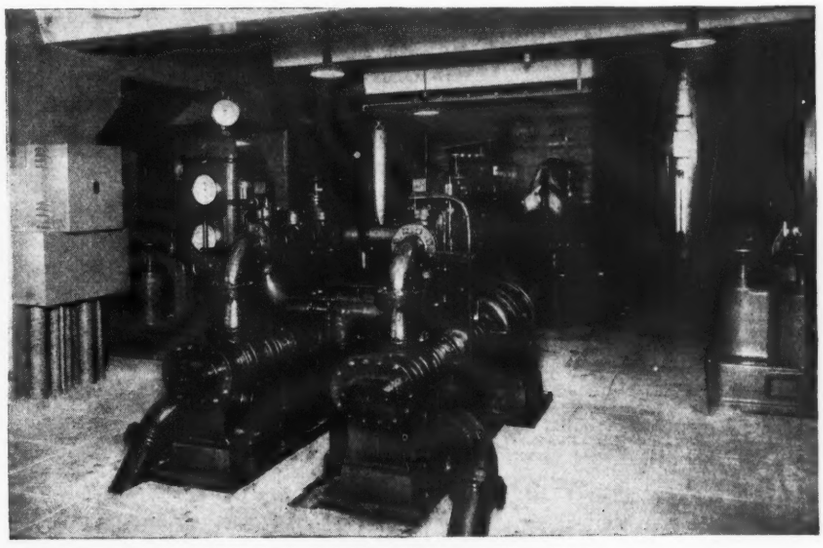


Fig. 5 — View of turbine room between two units, showing governor oil pumps in the foreground, governor pressure tanks, governor actuators and the butterfly-valve-operating mechanism in the background

The engineers for the project were Murray & Flood and W. S. Barstow & Company, Inc.; Albert S. Crane was consulting engineer.

The designs for the dam, conduits, intakes, surge tanks and spillway were made by the J. G. White Engineering Corporation and the design for the power house and substation was worked out by W. S. Barstow & Company, Inc.

The dam, conduits and intakes were built by the Arundel Corporation, and the power house, spillway and substation by W. S. Barstow & Company, Inc. The steel-pipe conduits were furnished by the Reeves Brothers Company; the penstocks and surge tanks by the Chicago Bridge & Iron Company; the intake gates by Phillips & Davies, Inc; the turbines, butterfly valves and tainter gates by the S. Morgan Smith Company; the turbine governors were built by the Woodward Governor Company; the generators by Westinghouse Electric & Manufacturing Company; and the transformers by General Electric Company.

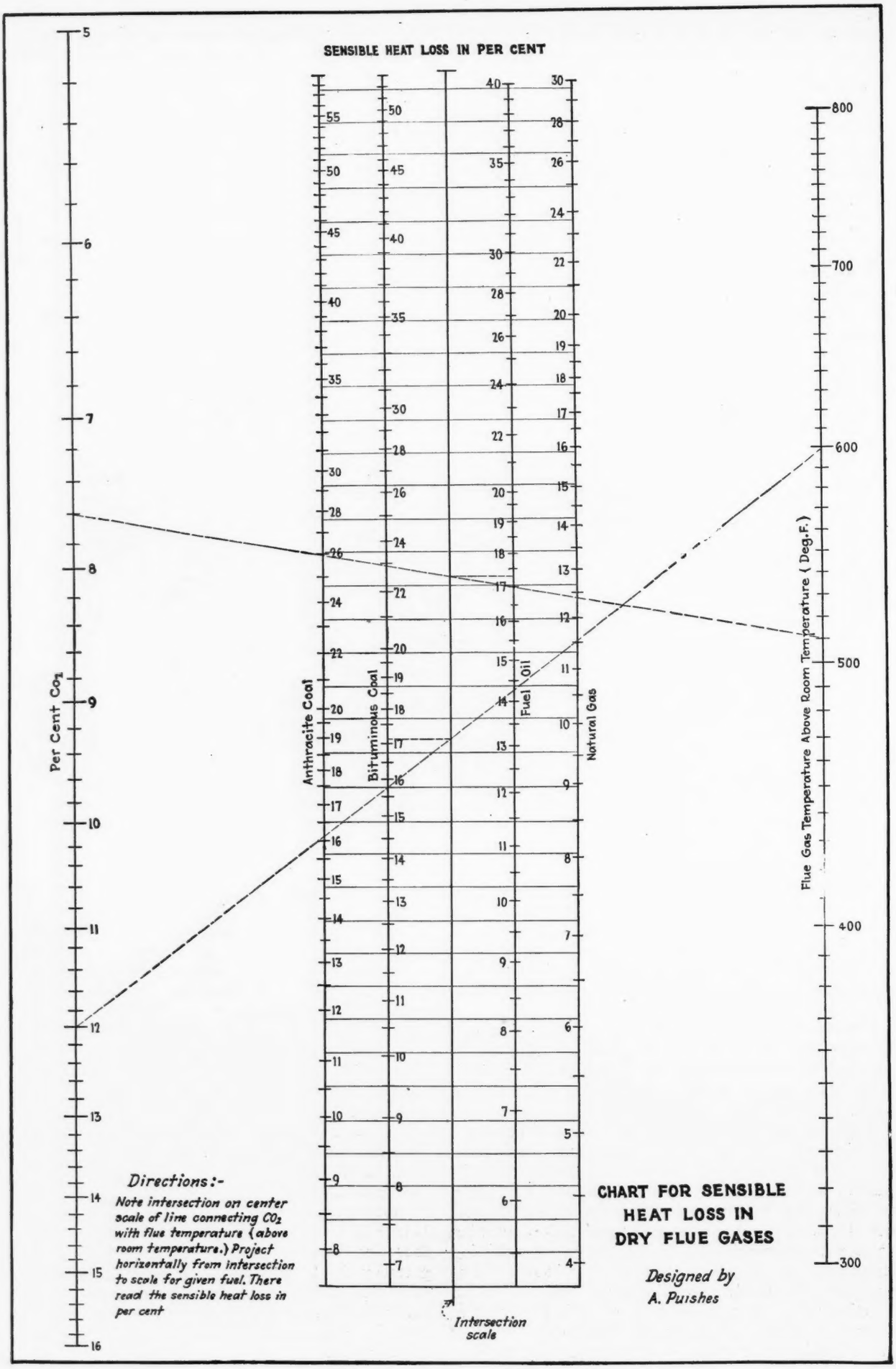

SENSIBLE HEAT LOSS IN PER CENT
Per Cent CO_2
Anthracite Coal
Bituminous Coal
Fuel Oil
Natural Gas
Flue Gas Temperature Above Room Temperature (Deg.F.)
Intersection scale
Directions:-
Note intersection on center scale of line connecting CO_2 with flue temperature (above room temperature.) Project horizontally from intersection to scale for given fuel. There read the sensible heat loss in per cent
CHART FOR SENSIBLE HEAT LOSS IN DRY FLUE GASES
Designed by
A. Puishes

Chart for Sensible Heat Loss In Dry Flue Gas

By A. PUISHES

THE RECENTLY published work of Dr. E. A. Uehling, "Heat Loss Analysis," has opened up a new lane of vision so far as the boiler house operating engineer is concerned. The demonstration of the equicalorific fuel unit opens up many ways to simplify combustion calculations and clarify the interpretation of operating data. It does still more, for it facilitates the charting of combustion formulas so that sufficiently accurate calculations may be performed by the operating engineer with the expenditure of a minimum of time and effort.

By far the most important heat loss to the operating man, as pointed out by Dr. Uehling, is that of the sensible heat lost to the dry flue gas. The data for its determination is readily available in most plants, but many men shrink from it because of the troublesome calculation that must be performed.

The writer has used the chart shown on the opposite page for this calculation with some success. It is plotted from data given in "Heat Loss Analysis" and is of sufficient accuracy for most practical purposes. The chart is self-explanatory, and the following illustrations drawn from the writer's experience will serve to demonstrate its application.

On an underfeed-stoker-fired job, the CO_2 is running about 12 per cent, with the flue-gas temperature 600 deg. above room temperature. To get the heat lost to dry flue gas, join 12 on the "Per Cent CO_2" scale at the left with 600 on the "Flue Temperature" scale at the extreme right. Get the point where it intersects the longest vertical line at the center of the chart and project this point over horizontally until it intersects the vertical scale marked "Bituminous Coal." The figure read will be 17.2 per cent heat loss to dry flue gas.

After determining the actual heating value of the coal being fired and calculating the loss by the conventional roundabout method, a figure of 17 per cent was obtained. With the usual doubtful reliability of coal analyses, which Dr. Uehling demonstrates so well, this discrepancy of slightly over 1 per cent is entirely negligible.

On a fuel-oil installation the process furnaces were doing about 7.6 per cent CO_2 with a flue temperature of 570 deg. Referring to the chart, we join 7.6 on the CO_2 scale with $570 - 60 = 510$ deg. above room temperature on the flue temperature scale as shown. By projecting over to the "Fuel Oil" scale (the light horizontal lines across the four scales will aid in making this projection) we get a heat loss of 17.3 per cent. A similar procedure is followed for anthracite coal and natural gas.

Readers who seek further light on the correctness of the chart or the data upon which it is based are referred to Dr. Uehling's excellent work. In fact, the book is strongly recommended to anyone having anything to do with boiler plant work. It is believed that presenting the data in this simple chart form will be particularly helpful in demonstrating the advantages of Uehling's method of treating combustion calculations.

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Engine Bearing Repaired by Arc Welding

THE ACCOMPANYING photograph shows how electric arc welding was used to repair a break in the bearing of the cast-iron bedplate of a horizontal steam engine.

This engine was being dismantled by the Freeport Light & Power Company, of Freeport, L. I., for shipment into Canada, when the fracture occurred at the bottom of the bearing housing. The car for shipment was already on the siding and it was necessary to make the repair as quickly as possible in order that the freight car should not be held over.

The work of repairing this engine was done on Sunday, thereby adding considerably to the cost. Four hours of preparation and 14 hours of actual welding time were required. The break, which was 22 in. long and 5 in. deep, was drilled and studded and filled in with the electric arc, as shown in the center foreground on the photograph.

This engine was repaired by the Hempstead Welding Company, of Hempstead, L. I., New York, and even though the job was completed on Sunday in 14 hours of continuous work the cost was only $140. The photograph and information concerning this job were obtained through the courtesy of the Lincoln Electric Company.

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Frame cracked at bottom of bearing housing

Fig. 1—Rotor with propeller blowers for a 22,500-kva., 3,600-r.p.m. generator

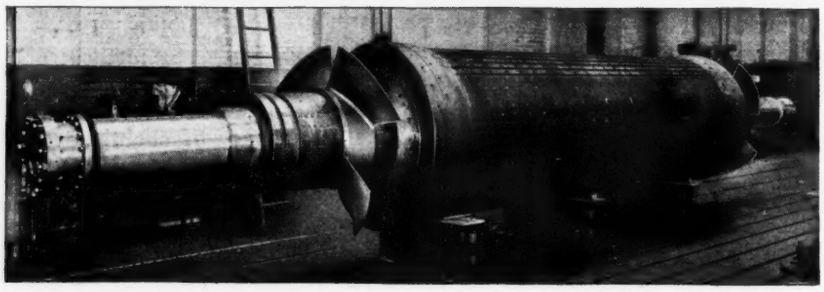


Fig. 2—Rotor with propeller blowers for a 75,000-kva., 1,800-r.p.m. generator

Propeller Blowers Ventilate Turbine-Generators

By C. M. LAFFOON
Power Engineering Department
Westinghouse Elec. & Mfg. Co.

IT IS DESIRABLE to circulate the cooling air of turbine-generators by internal blowers mounted on the rotor shaft ends, on account of the greater reliability and simplicity of operation. Some improvement in generator efficiency and reduction in over-all length can be obtained by using external blowers, but in most cases these advantages are more than offset by the advantages of greater operating simplicity and reliability of internal shaft blowers. As a general proposition, it can be stated that the majority of purchasers of turbine-generators prefer units with internal blowers.

Up until quite recently nearly all manufacturers of turbine-generators used some form of the centrifugal type of blower with a single side entrance for the rotor shaft fans. The principal advantage of this type of blower is that it requires the minimum amount of axial space per unit volume of air delivered; but the amount of air that can be delivered is limited by the area of the annular section between the rotor shaft end and the internal diameter of the blower. Consequently, there is a definite limit in the size of machine that can be built with this type of blower. The centrifugal blower has a further performance limitation, because the air is required to make a 180-deg. turn in entering the blower. With high entrance velocities, the air volume does not distribute properly over the axial length of the blower, resulting in excessive blower losses.

The double-entrance type of centrifugal blower was developed by Westinghouse to overcome these limitations. This design has been used on 12,500-kva., 3,600-r.p.m., and 75,000-kva., 1,800 r.p.m. generators. Experience has shown that this type of blower is expensive to build and complicated to assemble, on account of the special intake passages and discharge guides required.

To build still larger capacity 1,800- and 3,600-r.p.m. machines with internal blowers, and at the same time to simplify the manufacture and assembly of the blowers, consideration was given to using propeller-type blowers for this application. The propeller-type blower is inherently a high-efficiently design, and is capable of delivering large volumes of air at relatively high static pressures. Its principal advantages are low power requirements, simplicity, sturdiness and mechanical reliability. High efficiencies can be obtained by using relatively long intake and discharge chambers with properly arranged guide vanes.

When applied as internal blowers to turbine-generator

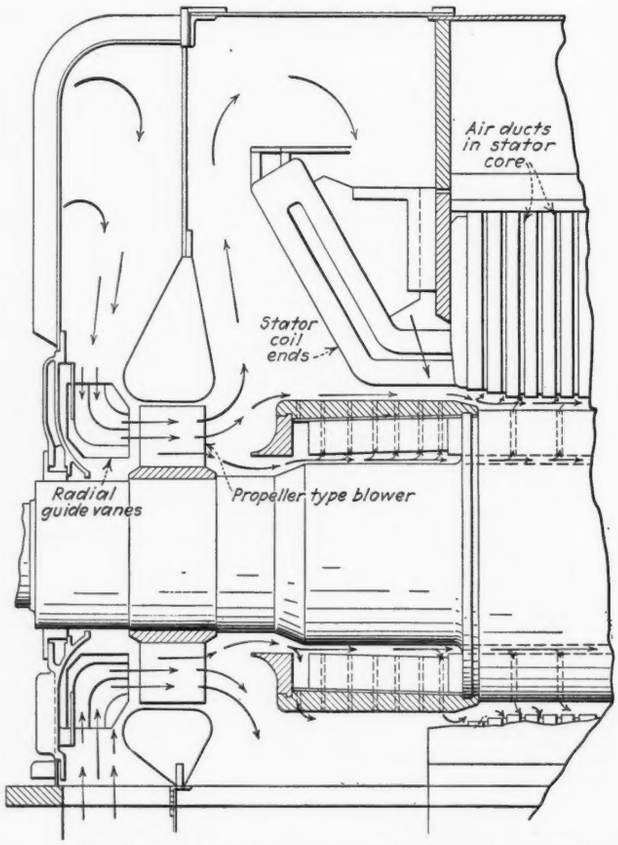


Fig. 3—Section through one end of turbine-generator, showing operation of ventilation system

shafts, the most efficient conditions cannot be provided for the intake and discharge sections, because the axial length of the rotor shaft ends must not be excessive. No greater length for the intake need be used for this type of blower than for any other type, and intake circumferential and radial guide vanes can readily be installed. In providing the discharge passage, it is necessary to offset the blowers with respect to the rotor end plates, and the end plates can be shaped to improve the efficiency of the discharge chamber.

The general arrangement of the propeller blowers on the shaft, with respect to the rotor end plates, the intake chamber with its guide vanes, and the discharge passage, is shown in Fig. 3. With this arrangement the propeller blower operates in series with the internal blowers in the rotor retaining rings and rotor body, and thus improves the ventilation of the winding and core.

Test results show an appreciable gain in the rotor ampere-turn rating with this type of blower over that obtained with centrifugal blowers, which operate normally in parallel with the internal-rotor blowers. From actual tests on propeller blowers with intake and discharge passages, as shown in Fig. 3, efficiencies of 40 to 55 per cent can be obtained, depending on the air volume and pressure requirements to be met.

Figs. 1 and 2 show propeller blowers mounted on the rotor shaft of a 22,500-kva., 0.80 power factor, 3,600-r.p.m. turbine-generator, and a 75,000-kva., 0.80 power factor, 1,800-r.p.m. turbine-generator, respectively. With this blower development, it is possible to build 3,600-r.p.m. turbine-generators with internal blowers up to ratings of 25,000 kva., at 0.80 power factor, and 1,800-r.p.m. generators up to 100,000 kva. rating.

Flywheel Effect Required For Synchronous Motors

By H. E. LARSON
Industrial Engineering Department
General Electric Company

IT IS necessary that a synchronous motor driving an air or ammonia compressor develop sufficient torque, but it is even more important to provide proper flywheel effect, either in the motor or in a separate flywheel, to limit current pulsation to the A.I.E.E. standard of 66 per cent of full-load current. To explain this standard, a motor having a rated full-load current of 100 amp. may draw a current varying between 133 amp. maximum and 67 amp. minimum.

A synchronous motor directly connected to a reciprocating compressor can be compared to a weight hung from a coil spring. If impulses are transmitted to the weight it will oscillate up and down with a magnitude depending on the difference between the frequency of the impulses and the natural frequency of the weight and spring as a system. If these two frequencies are nearly or exactly equal, reasonance occurs and the weight may oscillate so violently as to break the spring. By making the inertia of the weight appreciably greater, or even less, the oscillations can be reduced to a safe magnitude.

A synchronous motor responds to changes in load by shifting the position of the rotor with respect to the rotating field of the stator. In this way it acts like a spring, this ability being measured by a quantity called P_s, defined as the kilowatt input to the motor corresponding to a rotor shift of one electrical degree.

In actual compressor applications it is not possible to reduce the WR^2 below that value inherent in the motor. It is possible, however, to add a flywheel or a ballast ring to avoid a resonant condition. The figure shows two ballast rings on a rotor. These rings are used whenever there is not room on the compressor shaft for a flywheel, or when their use effects a saving.

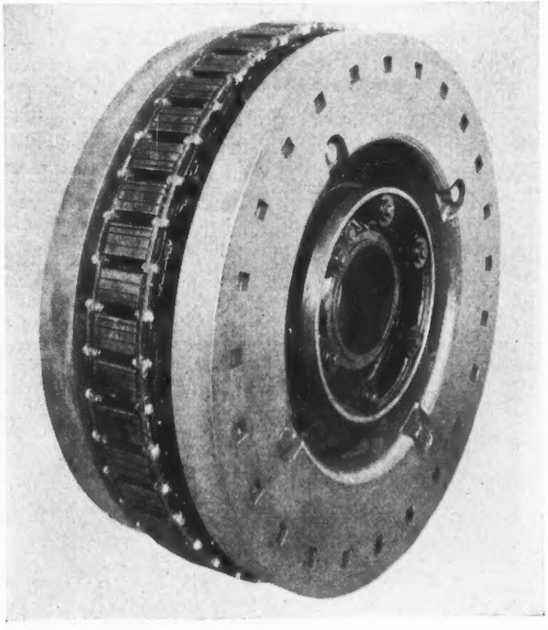
The total WR^2 required for a particular installation is:

$$WR^2 = \frac{C\ P_s\ f\ Hp}{S^4\ Kw} \times 57.3 \times 10^8$$

in which

WR^2 = Total lb.-ft.^{2} required.
P_s = Electrical input in kilowatts per electrical degree displacement.
f = Line frequency.
S = Speed in revolutions per minute.
Hp = Rated motor horsepower.
Kw = Input in kilowatts at rated motor horsepower.
C = Compressor factor.

The compressor factor C is a constant peculiar to a particular compressor for a definite value of current pulsation. It is determined mathematically from the crank-effort diagram of the compressor. Values of C for 66 per cent current pulsation are published in the N.E.M.A. Motor and Generator Standards, publication No. 30-2, October, 1930.



Synchronous motor rotor, showing squirrel-cage winding and ballast rings

An inspection of these factors will show that they depend somewhat on the number of cylinders and whether they are single- or double-acting, on the method of unloading, the difference between suction pressures of cylinders of the same compressor, the relatively large piston rod in a CO_2 compressor, and the angle between cranks. In general, any condition that causes the total amount of work done on each stroke to be different for each crank will increase the compressor factor.

Oil Engines in a Texas Asphalt Mine

By ORVILLE ADAMS

WHEN OPENING a mining property the management is immediately confronted with the problem of power supply. Usually the location is such that coal cannot be used economically, and an internal-combustion engine must be installed or a long transmission line run to a source of electrical supply, which latter may be expensive or the rate for energy too high to justify the investment. If the mine is a small one a gasoline engine, due to the low investment and availability of gasoline, may be advisable. But as soon as the power requirement reaches a substantial value an engine using cheap grades of oil becomes the economic choice.

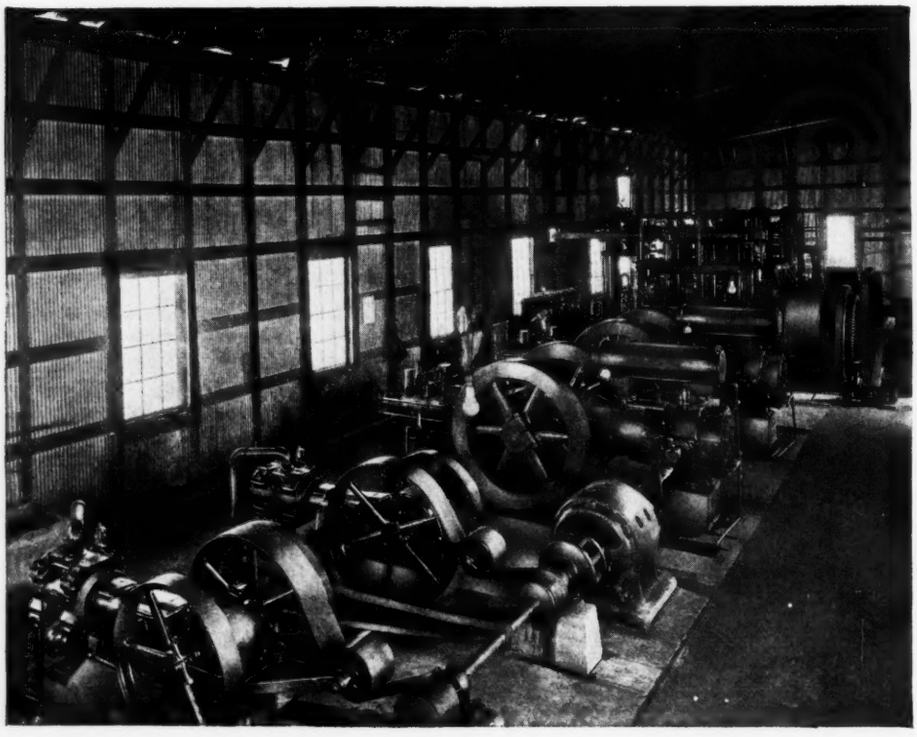
Such a plant is found in White's Uvalde Mines, one of the principal operating companies engaged in mining and crushing natural rock asphalt, 110 miles south of San Antonio, Texas. The plant has a daily capacity for 24 hr. of 6,000 tons, with a connected motor load exceeding the total horsepower of the oil engines by approximately 40 per cent, a fact which affects the load factor in such a manner as to give exceedingly favorable over-all economy.

The generating units comprise two Ingersoll-Rand three-cylinder, 330-hp., solid-injection engines directly connected to 220-kw., 2,300-volt, 3-phase, 60-cycle alternators. These engines supply the current for the various motors at the crushing plant, a motor for driving two auxiliary compressors, and for operating a dragline excavator and an electric shovel at the mine. The connected load in motors at the mine and crushing plant is approximately 900 hp., yet the work throughout the 24-hr. operation is so scheduled that the 660-hp. plant takes care of the demands without overloading the machines. Obviously the 900 hp. is not all needed at any one time, the work being so timed that when the large gyratory crusher is operating the electric shovel at the mine is idle. When the train of dump cars returns, the shovel starts loading again just at the time the crusher has finished the previous charge of rock. The lights for the plant are supplied by a 35-kw. generator driven by a horizontal 55-hp. oil engine.

Compressed air required for numerous drills and air tools is supplied by two 110-hp., oil-engine-driven compressors, each of 603 c.f.m. piston displacement. The spare compressors for stand-by, with a capacity of 368 c.f.m., are arranged to be belted to a common line-shaft that is motor-driven, as shown in the illustration.

The oil engine plant was installed in March 1926 and has operated at a very high load factor at all times. No trouble in the operation of these engines has occurred since they were installed four years ago and the annual repair bill has been small, so Frank Coughlin, general superintendent, reports.

One operator only is employed, and he not only looks after the engines, but makes the necessary repairs when needed. In connection with fuel and lubricating oil, the plant averages 0.40 lb. of fuel per brake horsepower-hour, and 4,000 b.hp.-hr. on a gallon of lubricating oil. Cooling water is pumped from a distant mine pit, and is therefore unsuitable for cooling purposes in the raw state. As it contains from 6 to 7 gr. of hardness, an inclosed system for water circulation is used and the make-up water is softened. This greatly reduces the solid content, with the result that there is little scale in the jackets. Only one cylinder head has been replaced since the installation.



Power plant of the White's Uvalde Mines, containing diesel generating sets and horizontal diesel-driven air compressors

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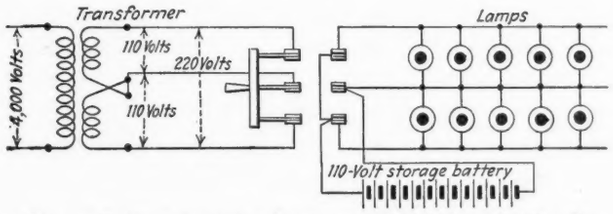
...RIGHT OUT OF THE PLANT...

Control Battery Used for Emergency Lighting

AT A SUBSTATION arrangements were made to shut down for four hours to do several repair jobs. All the power was cut off from the station, and when everybody was on hand to do the work it was discovered that making the station dead also cut out the lighting



Storage battery for 110 volts connected to 110- and 220-volt lighting system

system. Normally the lighting was supplied from a 15-kva. 4,000-volt to 110- and 220-volt transformer. In the substation there was a 110-volt control storage battery and it was connected to the lighting circuit as in the diagram, which allowed the work to be done in the plant with the outside power cut off entirely.

Butte, Mont. RALPH E. MACKAY.

Orifices For Building Heating Control

THE RESPONSE of B. F. Randel in the Dec. 2d number in which the orifice system as applied to direct radiation systems of building heating was discussed and suggestions made for controlling distribution is an encouraging sign in that it indicates a recognition of the inherent advantages of orifice usage.

However, analysis of the suggestions set forth indicates that Mr. Randel may not be familiar with some of the advancements made in the eastern section of the country which go a long way toward achieving ideal means of effecting satisfactory control of distribution.

For a long period of time steam heating design was stagnant. Standard practice was to use radiator traps with gravity or vacuum return. A variation and advancement in the system is found in the use of the differential vacuum control, in which advantage is taken of the specific volume and temperature changes of steam under varying conditions of vacuum. A major responsibility is placed upon the steam-heating contractor to provide a tight piping system against in-leak of air under high vacuum. Any advantages claimed for quick warming up are common to orifice distribution, for the proper system balance effected produces the desired results as well as uniformity of heating.

Isolated use of individual thermostatic supply valves may be justified for individual requirements, but a major installation of this character is very expensive. The maintenance possibilities of such a system over an extended period of years is a matter for serious consideration. In cases of partial installation, restricted inlet opening of the automatic valves may unbalance the system so as to necessitate overheating of the spaces having radiators equipped only with ordinary valves.

One manufacturer of an orifice system utilizes compound orifices; that is, in addition to the radiator orifices an orifice is placed in each branch main and riser. Automatic regulation is effected by a roofstat associated with a mercury balance conveniently located in the basement or engineer's office. This balance modulates the opening of the main control valve. A variator, on the balance panel, provides for manual control. At the present time provision for zoning under automatic control necessitates duplication of expensive control mechanisms. Manual distribution valves can be installed for each zone. The manufacturer of this equipment adheres to standard practice concerning vacuum systems.

Paralleling this activity in orifice development is the contribution made by another manufacturer along different lines. The compound orifice feature is omitted and radiator traps are optional. The fact that systems are working without traps is strong enough proof of the feasibility of their omission. Facts remove the consideration from the realm of conjecture. The building is divided into as many vertical and horizontal zones as required, and in each zone is placed a remote-controlled motor-operated modulating valve which maintains any degree of flow between 5 and 100 per cent, varied by 5 per cent increments. The control panel for the zone valves is centrally located and has transmitter dials graduated to the modulating schedule indicated above. The zone-control method gives a flexibility that cannot be achieved with the group control previously described, and makes for greater economy. It provides for a differential control, subject to manual regulation, without the complication of a spring-loaded check on each radiator, as proposed by Mr. Randel.

It is not apparent wherein the system proposed by Mr. Randel would be conducive to economy, and the use of a high-pressure drop of 10 lb. through an orifice might produce objectionable noise. Formerly, radiator orifices were designed for 1-lb. drop, but current practice favors 3 lb., with which differential greater flexibility of regulation is obtained. The 10-lb. drop is not necessary for better balance conditions and rapid circu-

lation, inasmuch as theoretical considerations are substantiated by the performance of low-pressure-drop systems. A high pressure in a radiator means losses due to overheating and requires use of traps.

The systems herein discussed indicate operating economies, based on steam or coal usage, of from 20 to 40 per cent over the straight vacuum types. As to the relative merits of the various systems, I feel that the zoned orifice system is a distinct contribution to the art, in that it calls for the minimum amount of equipment necessary to secure the desired control flexibility, and the need of radiator traps is eliminated with attendant reduction in capitalization and maintenance. As compared with unit thermostatic valves on each radiator, capitalization charges will be one-half or two-thirds lower, which consideration is of chief importance in figuring carrying charges or amortization of investment defrayed by operating savings.

The use of long-distance or remote-reading recording thermometers installed in key locations around the building, or a caliscope instrument, assist in obtaining maximum savings. Such equipment increases capitalization materially, but it should not affect the price differential noted.

There is an urgent need for rationalized analysis of mechanical problems on the part of the consulting engineer. It has come to be realized that the power plant equipped to secure the last point in efficiency may be an economic failure; and so it is in building equipment engineering when reflection is focused upon the current trend toward loading the operating man with the last word in engineering development. It costs money to keep in style. The truly progressive engineer tempers his imagination with hard reasoning. He must needs get out in the field and check up on the performance of his creations.

M. N. Longley,
New York, N. Y. New York Telephone Co.

Markers for Indicating Wattmeters Facilitate Reading

WE HAVE over 100 indicating meters of the horizontal edgewise type on our main switchboard, and in routine operation the operator is required to take hourly readings from about 25 of these meters.

We find it a great help to mark each meter with its circuit name or number so that readings can be taken without having to check the larger label further down under the meters.

Our method of marking is to use labels lettered with waterproof drawing ink on ordinary white writing paper. A strip ½ in. wide x 1½ in. long is suitable for most names and does not obscure the scale to an objectional degree. Wattmeters with a zero center are marked "in" and "out" (tie lines).

The labels are pasted on the *inside* of the glass in a central position at the lower edge.

The adhesive we use to attach the paper to the glass is called "flexible colloidian" and can be had at any drug store. A camel hair brush is used to apply it to the glass, and then the label is placed and pressed down with the thumb. It must be worked fast, as this material dries almost immediately after applying.

The label can be seen clearly through the colloidian and will not yellow as much as it would with varnish.

Nashville, Tenn. Thomas E. Miller.

Testing Transformers Must Have Sufficient Capacity

WHEN MAKING high-voltage tests on large generator windings the power capacity necessary to supply the charging current of the windings must not be overlooked. The windings of a large generator act as a high-capacity condenser and require a fairly large power capacity in the testing equipment to supply the charging current. This was demonstrated in a test made on the windings of a 28,000-kva., 11,000-volt waterwheel generator after rewinding.

The most convenient transformer for supplying the test voltage was a 50-kva., 11,000 to 32,000-volt unit. When this transformer was connected to the generator's windings it was found to be too small to supply the charging current and the voltage could not be raised to the required test value. When a 150-kva. transformer was substituted for the 50-kva. unit, the test was completed in a satisfactory manner.

Buffalo, N. Y. M. C. Maguire.

Pump Troubles Often Caused by Faulty Suction Line Construction

SOURCES of trouble in pumps failing to deliver their rated capacity, erratic delivery and losing prime, can often be traced to a faulty foot valve and the submergence of the suction line.

The threaded portion of a foot valve is often short, and unless the suction pipe thread is cut as short as the foot valve thread a portion of the suction pipe will project into the chamber of the foot valve when the joint is made up. This projection will prevent the flapper of the valve opening as much as would otherwise be possible, thereby decreasing the area of the suction pipe and capacity of the pump and causing an erratic delivery by the baffling effect of the flapper in the path of the water. The projecting pipe often permits the velocity of the entering water to wedge the leather flapper tightly into the suction pipe. Then if the weight of the flapper is not sufficient to remove the wedged leather from the pipe, it becomes impossible to prime the pump until the leather is reseated.

Another important point in connection with suction lines is to make sure that the end of the suction line is submerged sufficiently to prevent the pump from drawing in air. If a suction line ends a short distance beneath the surface of the water, the velocity of the incoming water will create vortices or whirls which will carry air to the pump. The distance that the end of the suction line should be submerged is dependent both on the size of the pipe and the velocity of the incoming water. A safe plan to follow is to have one foot submerged for each inch in diameter of suction pipe for sizes 2 in. and above; sizes above 8 in. may be safely held at 8 ft., except in extraordinary cases.

If this submergence is impossible, a disk three or four times the diameter of pipe tack-welded around the suction pipe and as close to the end as practical will prevent air from being drawn into the pump from this cause.

As tight joints are essential in suction line piping, particular care is required in threading and making up the joints.

All pipe machines and stocks have indicating marks

for the correct depth of a standard thread. These marks are all right if the thread of the fitting that the pipe screws into is the proper depth—if not a leaky thread is on the pipe. It is usually more satisfactory, even though more time is required, to take two cuts instead of making the full depth of the thread in one cut. This method permits of gaging the distance the thread will screw into the fitting. When threads are cut this way and the joint made up tightly with a metal-to-metal contact, there will be no need of "dope" to produce a tight connection.

Brooklyn, N. Y. WILLIAM ANDERSON.

Determining Average Demand of Fluctuating Loads

I READ with considerable interest the article by R. K. Long in the Dec. 16, 1930, number of *Power* on "Determining Average Demand of Fluctuating Loads." He describes a method of measuring average power in a circuit by means of a wattmeter and a stop watch. Evidently instead of "wattmeter" he means "watt-hour meter."

Where such measurement of average power is made with the intention of controlling the billing demands it might be desirable to go a step further and install a watt-hour demand meter with some definite time interval, such as fifteen or thirty minutes. This meter will give a record over a longer period of time and will be more truly comparable to the measurements made by the power company if the energy to be measured is purchased.

Detroit, Mich.

A. S. ALBRIGHT, *Supt. of Meters,*
Detroit Edison Company.

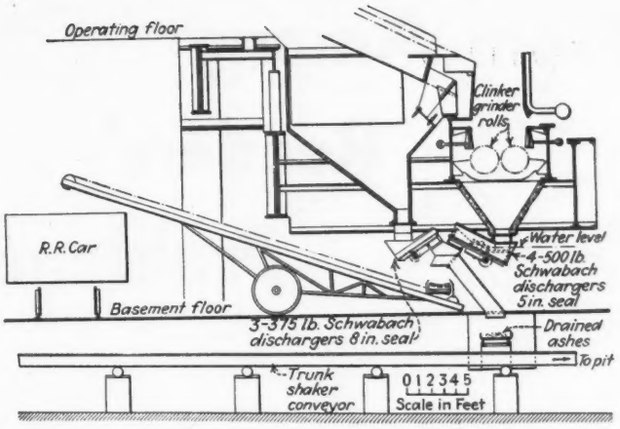
Ash Handling at West Station

THE ARTICLE entitled "Submerged Grinder Rolls Prevent Overheating," by R. A. Foresman, in the Jan. 20 number has, no doubt, received a great deal of attention. With the increase of ratings at which boilers are being operated and the consequent increase in fuel-burning capacity per square foot of stoker area, the question of ash disposal has moved to the fore.

Few will take issue with the statement made in the next to the last paragraph of Mr. Foresman's article that, when it comes to disposing of large quantities of ash, it should be removed as fast as it is produced by the clinker grinders and that the place to store refuse material is outside of the plant. The designers of large power plants have become aware that great basement heights to accommodate large ashpits is a wasteful practice.

Mr. Foresman has also properly stressed the importance of an effective water seal. Not only can the air delivered to the pit be thereby controlled in the burning out of the combustible in the ashes above the grinder, but, what is more important, the gases are prevented from escaping into the sluiceway. From here they leak into the basement, and if one of the boilers served by the sluiceway is down for repair the gases find their way through this boiler and soon make the operating floor a place difficult to breathe in.

No mention is made in the article as to how the ashes are removed from the water-filled ashpit. In this connection I believe readers will be interested to learn how the ash-disposal problem was solved at the West power station of Berlin, because the same points that Mr. Foresman brings out were considered in its design. The West power station is the largest and most up to date in Europe. Visitors to the World Power Conference last summer had the opportunity to view the plant in the course of construction. The boilers are fired with Taylor stokers 20 retorts wide and 49 tuyères in length.



Ash Handling at West power station, Berlin

The accompanying illustration shows the ash falling into a device filled partly with water. The water is kept at a certain level by means of float control or overflow, thereby maintaining a seal of about five inches. A paddlewheel carries the ashes upward along the inclined bottom at a slow rate of speed, giving ample time for the ash to drain thoroughly before it is discharged, either by means of portable conveyors into railroad cars or through the chute to the mechanical conveyor system which takes it to the yard pit. The crushing rolls are not submerged, because that was not considered necessary in this case, as the air supplied to burn the combustible in the ash will also be effective in cooling the rolls.

I had the opportunity to see this form of ash-removal system in operation in many other plants abroad. The water and power consumption is small, and the size shown in the illustration will handle fifteen-inch clinkers without difficulty. ARNOLD WEISSELBERG.

Jersey City, N. J.

Two-Stage Feed Pumps Protect Economizer

FEED PUMPS of the outside-packed-plunger type took the water from an open exhaust-steam heater and delivered it through an economizer to high-pressure boilers. Thus the economizer was subjected to the full boiler pressure, and to this fact was attributed occasional occurrences of ruptured tubes. To relieve the situation, the engineer hit upon the plan of substituting a pair of turbine-driven two-stage centrifugal pumps as boiler feeders. From the first stage of each pump the water was piped to the economizer, through which it is circulated back to the second stage and thence to the boilers. Thus, the economizer had to withstand only the comparatively low first-stage pressure.

Inasmuch as the initial heating of the water in the open heater raised its temperature almost to the boiling point, the heater was set at an elevation that secured a static head on the pump suction of about twelve feet.

St. Louis, Mo. A. J. DIXON.

From Among Readers' Problems

Conducted by
L. H. MORRISON

CAPACITY OF AMMONIA COMPRESSOR—*What is the capacity of an ammonia compressor with an 8-in. diameter and 20-in. stroke, single-acting cylinder, when operated at 100 r.p.m., if the volumetric efficiency is 85 per cent? The head pressure is 114 lb. gage and the back pressure is 45 lb. gage.* J.W.R.

The cubic feet of gas handled by a compressor is found by the equation: $Vol. = L \times A \times N \times E_v$, when

L = Stroke in ft. = $\frac{20}{12} = 1.667$

A = Piston area in ft. = $0.7854\ (d)^2$.

In this case $0.7854 \left(\frac{8}{12}\right)^2 = 0.349$.

N = Delivery stroke per minute, which for the single-acting machine is equal to the r.p.m. = 100.

E = Volumetric efficiency, 85 per cent.

Substituting these values we have

Suction volume = $1.667 \times 0.349 \times 100 \times 0.85 = 49.44$ cu.ft.

Therefore the volume of suction gas handled per minute by the compressor is 49.44 cubic feet.

The next step is to ascertain the refrigeration performed by the ammonia, which, after evaporation, has a volume of 49.44 cu.ft., first finding the weight of this ammonia. The question does not state the condition of the suction gas, but it will be assumed that it is superheated 10 deg. above the boiling temperature, corresponding to the suction pressure of 45 lb. gage. The boiling temperature is 30 deg. F., and with a 10 deg. superheat its total temperature is 40 deg. F. The Bureau of Standards tables on the properties of ammonia show that the volume of a pound of ammonia gas at 45 lb. gage pressure and 40 deg. F. temperature has a volume of 5.06 lb. and a total heat of 626.8 B.t.u. Consequently, the 49.44 cu.ft. has a weight of $49.44 \div 5.06 = 9.77$ pounds.

As stated, each pound of suction gas contains 626.8 B.t.u., and the ammonia tables reveal that at a head pressure of 114 lb. gage a pound of liquid ammonia in the receiver should have a temperature of 70 deg. F. and contain 120.5 B.t.u. The difference between the heat in the suction gas and the heat in the liquid is the heat absorbed in the evaporating coils. Consequently, each pound of ammonia handled absorbs $626.8 - 120.5 = 506.3$ B.t.u. As there are 9.77 lb., the total heat absorbed per minute is $560.3 \times 9.77 = 4{,}946.5$ B.t.u. As the removal of 200 B.t.u. per minute is considered a refrigerating duty of one ton, the machine would be performing a duty of $4{,}946.5 \div 200 = 24.7$ tons.

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INCREASED POWER BY CLUTCH SLIPPING—*How is it possible to gain more power from an engine by slipping the clutch? I know that this is done in the case of automobiles and hoists.* D.A.

Broadly speaking, the driving power is not increased by slipping a clutch, but under certain conditions the engine will pull a load which it would not with an unslipped clutch.

The gasoline engine has a torque characteristic such that at low speeds the torque, or what might be called the pulling power, drops to practically zero. If, for example, a car is moving slowly in high gear, the torque of the engine at this engine speed may be such that it cannot overcome the resistance of the car, and it will stall. When the engine shows such symptoms, one of two things can be done. The drive can be shifted to low or to second speed, so the engine can be run at a higher speed, and so give a higher torque, or the clutch may be slipped and the engine speeded up. In the latter case much of the engine's power is lost by frictional heat at the slipping clutch, but enough is transmitted to the wheels to keep the car in motion.

Under a second set of conditions an engine may appear to carry a greater load with a slipping clutch. A hoist may be starting a loaded bucket and the engineer may let the clutch slip. The explanation is that from the point of starting until the bucket reaches its highest lifting speed, the load on the driving motor or engine is made up of the dead weight of the bucket plus the load due to accelerating the bucket, or $W + \frac{Wa}{g}$ where W is the weight, a the bucket acceleration and g the acceleration due to gravity. If the operator tries to bring the bucket up to speed quickly the acceleration load $\frac{Wa}{g}$ may be so large that the engine cannot lift the bucket. By slipping the clutch the acceleration a is reduced to a point where the engine can bring it up to speed, but at a slow rate.

PREVIOUS QUESTION
DISCUSSED BY READERS

THE QUESTION

WHAT is the maximum probable equivalent evaporation that one should expect from a plant containing three water-tube boilers totaling 10,000 sq.ft., when hand-fired with natural draft at 90 per cent rating, with a very high grade run-of-mine coal? What should be expected at 30 per cent rating during the 14-hr. night shift? How much could the efficiency and per cent rating be increased if stokers were installed? Two of the boilers are sixteen years old and the third is seven years old. M.H.C.

WITH the stokers available for such a plant, there must be extenuating circumstances for the consideration of hand-fired operation. Assuming 13,000-B.t.u. coal in the calculations, hand firing at 90 per cent rating and 57 per cent efficiency requires 4,066 lb. of coal per hour, with an equivalent evaporation of 7.6 lb. of water per pound of coal. Hand firing at 30 per cent rating and 43 per cent efficiency requires 1,796 lb. of coal per hour, with an equivalent evaporation of 5.8 lb. of water per pound of coal.

Banking one boiler and firing two for 30 per cent total rating and 50 per cent over-all efficiency will require 1,545 lb. of coal per hour, with an equivalent evaporation of 6.7 lb. of water per pound of coal.

Banking two boilers and firing one for 30 per cent total rating, or 90 per cent on one boiler, and 57 per cent efficiency requires 1,355 lb. of coal per hour, with an equivalent evaporation of 7.6 lb. of water per pound of coal.

Stoker firing at 90 per cent rating and 72 per cent efficiency will require

3,219 lb. of coal per hour with an equivalent evaporation of 9.64 lb. of water per pound of coal.

Stoker firing at 90 per cent rating with two boilers on line and one spare, at 74 per cent efficiency, requires 3,132 lb. of coal per hour, with an equivalent evaporation of 9.9 lb. of water per pound of coal.

On the other hand, stoker firing at 30 per cent rating and 52 per cent efficiency requires 1,486 lb. of coal per hour, with an equivalent evaporation of 7 lb. of water per pound of coal.

Stoker firing at 30 per cent total rating with one boiler on the line and with two banked, and 70 per cent efficiency, will require 1,073 lb. of coal per hour, with an equivalent evaporation of 9.64 lb. of water per pound of coal.

Under ordinary circumstances and assuming the boilers in well-kept condition, the difference in coal consumption indicates a stoker installation will pay for itself in less than three years, without figuring labor saving or probabilities of a cheaper coal.

The efficiencies used are in line with my experience and are averages that should hold good for every-day operation. J. N. H. CHRISTMAN.

Cleveland, Ohio.

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A HIGH GRADE run-of-mine coal, such as Pocahontas, should average at least 14,300 B.t.u. on an as-received basis. Many analyses of this grade of coal will show values of 14,500 to 14,600 B.t.u., depending on the moisture content.

As to the maximum probable equivalent evaporation, it is anyone's guess what this might be. Roughly, boiler and furnace efficiencies would approximate: Hand firing, 50 to 65 per cent, and for stokers, 60 to 75 per cent.

Undoubtedly there are many cases where higher efficiencies have been reported for hand firing and lower efficiencies for stokers, but these values represent good fair averages. Using this as a basis, evaporation figures based on 1,000 B.t.u. per pound of steam and 14,300-B.t.u. coal would be: Hand firing, 7.00 to 9.30 lb. of water per pound of coal; stoker firing, 8.50 to 10.70 lb. of water per pound of coal.

As to evaporation at 30 per cent rating, this figure would be materially lower than evaporation figures at 90 per cent of rating, and could only be an estimate. The advantage of stokers is the increased boiler economy, for an increase in efficiency from 50 to 60 per cent means a 20 per cent saving in fuel, and from 65 to 75 per cent means a 15 per cent saving in fuel. A saving in labor is also effected.

Higher ratings are possible with stokers. With hand firing 150 per cent rating is about the peak that can be expected with natural draft, so in addition to other advantages higher ratings can be obtained with stokers than possible with hand firing. If the load is such that all three boilers must be operated now, with stokers the load could be carried on two boilers, with a spare boiler for repairs.

More uniform regulation of the fire is possible.

While run-of-mine coal is burned now, screenings could be used in stoker operation.

More smokeless combustion is possible. Hand-fired furnaces are smoky because soot is produced in or near the fuel bed and cannot be burned in the limited combustion space of the furnace.

Sheboygan, Wis. ABBOTT GLICK.

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A HIGH-GRADE run-of-mine coal will contain about 14,500 B.t.u. dry. If the steam load is fairly constant at 90 per cent of the rated capacity of the boilers during the ten-hour load period, the best efficiency that can be expected from good hand firing is about 70 per cent. The equivalent evaporation will then be 10.45 pounds.

In a well-operated plant two of the boilers should be banked during the light-load period of 15 hr., which would bring the load on the third boiler, assuming they are all of the same size, up to 90 per cent of rated capacity. Under these conditions the evaporation on the night load would be approximately the same as during the day load. The banking loss should be slight if the boiler dampers are tight.

Stokers applied to these boilers would most likely be of the single-retort underfeed type, with the grate area proportioned to develop maximum efficiency at 125 to 150 per cent of rated capacity of the boilers. If the proper setting height could be obtained the efficiency should be in the neighborhood of 75 per cent at 125 per cent to 150 per cent rating. The plant should be operated with two boilers in service during the day and one during the night, the other being banked. That would leave the third unit as a spare. The stoker on night load should operate at 70 to 72 per cent efficiency.

If stokers are installed primarily to increase capacity the limits of such increase are: (*a*) the size of stoker that can be installed; (*b*) the ability of existing flues, breechings and stack to carry away the products of combustion; (*c*) the setting height that can be obtained to provide sufficient furnace volume for complete and smokeless combustion; and (*d*) the economic limit of sensible heat lost up the stack as indicated by the temperature of the gas leaving the boiler and determined by the type of boiler, design and condition of the baffles and the rate of driving.

In all probability the economic limit of capacity in a plant 16 years old would be no greater than 200 per cent of normal rating, because the cost of changes to building and foundations to obtain higher ratings would likely be out of all proportion to the increase obtained. LLOYD R. LEATHERMAN.

Chicago, Ill.

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THE boiler plant, if properly designed, would require approximately 200 sq.ft. of grate surface in order to burn efficiently a good grade of bituminous coal. At 90 per cent rating, the plant would be evaporating 32,000 lb. of water per hour. The probable maximum factor of evaporation obtainable at this rating would be in the neighborhood of 8.5 lb. of water per pound of coal fired. It would be necessary to burn about 19 lb. of coal per hour per square foot of grate surface to obtain this figure. The over-all efficiency that would result from these operating conditions would be 57 per cent, using coal with a heating value of 14,500 B.t.u. per pound.

When operating at 30 per cent of rating the boilers would be evaporating 10,350 lb. per hour. An equivalent evaporation of little over 5 lb. could be expected, resulting in an over-all efficiency of 33.5 per cent.

If overfeed mechanical stokers were installed, considerable improvement could be made on the over-all efficiency. An equivalent evaporation of 9.5 lb. could easily be obtained when operating at 90 per cent rating, with an over-all efficiency of 63.5 per cent. With sufficient stack capacity and mechanical stokers, the rate could easily be pushed up to 150 per cent of boiler rating, thereby securing the maximum efficiency. If this were done, the entire load, in all probability, could be carried with two boilers of 6,000 square feet.

Fairfield, Conn. H. W. OGGENFUSS.

A Question for Our Readers

ONE of the fundamental principles is that two gases in a container will separately fill the entire vessel, independent of the other's pressure, and the pressure exerted is the sum of the two gas pressures. This also applies to a vapor and a gas. If so why do not steam and air mix in a radiator? C.C.

Suitable answers from readers will be paid for[1] and published in the March 24, 1931, number

[1]Instead of cash payment for answers published, readers may select any one of the following books. (Be sure to state the book desired.)

Morrison's *American Diesel Engines*; Walker and Crocker's *Piping Handbook*; Norris and Therkelsen's *Heat Power*; Emswiler's *Thermodynamics*; Church's *Steam Turbines*; Uehling's *Heat Loss Analysis*; Croft's *Steam Power Plant Auxiliaries and Accessories*; Powell's *Boiler Feed Water Purification*; Osborne's *Power Plant Lubrication*; Moyer and Fittz' *Refrigeration*; *Rietschel - Brabbee's Heating and Ventilation*; Annett's *Electric Elevators*.

Heat, Light and Power Costs in New York City Hotels†

By EDWARD C. ROMINE, C.P.A.
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Specialists in Hotel Accounting

THIS series of studies is based on answers to questionnaires submitted by members of the West Side Association of Hotels, New York City, most of the hotels included being of the semi-residential type. The fourteen answers received are here presented in comparative form.

Total Cost Per Day

All averages quoted are simple averages, not weighted. The average cost was 25c. a day for each available room, which is practically the same as the cost obtained in a recent survey of 75 hotels by Cornell University.

In the present report, "cost per room" is the basis used for comparisons. It is realized that it takes more steam to heat a 13x18-ft. room than a 9x12-ft. room. Also that the relative amount of public spaces is an important factor. The cubical contents of the respective hotels were not available, however, and therefore the "per-room" basis was the only measuring stick that could be used. In general, these hotels are much alike; consequently, it is thought that, for all practical purposes, these comparisons are fair.

Table II gives the cost per available room in each of the hotels.

An excess in cost of five cents a room a day may not sound like very much, but in a 300-room hotel it amounts to $5,400.00 a year.

High-Pressure Plants Spend More

All of the hotels reported making their own steam, so that no costs of heating by central station steam were developed. Ten hotels reported operating on high-pressure steam, and the re-

†Paper made available by Standard Statistics Company, Inc.

TABLE I — SUMMARY OF

Hotel Number	1	2	3	4	5
Number of rooms (approximate)	150	225	250	300	300
Do you operate on high or low pressure?	Low	High	High	Low	High
Do you buy steam?	No	No	No	No	No
Do you make your own electricity?	No	No	Yes	No	No
Average kw.-hr. of electricity used yearly		229,549	355,250	282,280	161,911
If you make electricity are you connected with Edison service for emergency purposes?			Yes	No	
What does this service cost?			$1,680.00		
Kind of coal used	No. 1 Buck.	Buck.	Soft and Dust	No. 2 Buck.	No. 1 Buck.
Average cost yearly	$2,200.00	$8,062.76	$7,383.46	$5,850.00	$7,370.00
Average tons consumed yearly	400	1,428	1,758	990	1,100
Average price per ton	$6.75	$5.60	$4.20	$5.90	$6.70
Average cans of ashes daily	6	15	10	9	9½
Annual cost of removing ashes and rubbish	$300.00	$600.00		$240.00	$540.00
Do you use mechanical stokers?	No	No	No	No	No
Do you buy your ice?	Yes	Yes	No	Yes	No
Average cost per 100 lb.	$0.40	$0.32		$0.325	
Pounds bought yearly	8,000	9,893		300,000	
Do you make your own ice?	No	No	Yes	No	Yes
Estimated cost per 100 lb.					
Pounds made yearly			328,500		
Have you a refrigeration plant?	No	Yes	Yes	Yes	Yes
Do you have circulating ice water?	No	No	No	No	No
Do you operate oil burners?	No	No	No	No	No
Do you operate your own laundry?	No	Yes	No	No	No
Do you have an electric sign?	Yes	No	Yes	2	Yes
Approximate candlepower, watts	700		6,020	2,400	
How much electricity do you sell yearly? (kw.-hr.)		None	101,000		
Do you meter it?	Yes		Yes	Yes	Partly
Amount sold in dollars	$800.00		$7,000.00	$375.00	$3,700.00
Rate charged	$0.07		Edison rates	$0.05	
How much ice do you sell yearly?	None	None			None
Rate charged					
Total annual payroll (detailed below)	$1,920.00	$8,242.00	$14,295.66	$8,240.33	$14,000.00
Total annual cost of payroll, electricity, coal and ice	$8,249.26	$26,659.28	$24,904.17	$26,109.95	$25,706.00

ANALYSIS OF PAYROLL	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Chief engineer	1	$16.00			1	$60.00	1	$52.50	1	[3]$55.00
Day engineer			2	40.00 39.00	1	45.50	1	42.00	1	[3]39.00
Night engineer			1	39.00	2	45.50	1	35.00	1	[3]39.00
Day fireman			1	33.00	1	40.00			1	[3]33.00
Night fireman	1	[4]9.00			1	35.00	1	35.00	1	[3]33.00
Oilers										
Electricians									1	[3]39.00
Ice man										
Plumber										
Handy man	1	[4]11.50	1	2 hr. 7.50					1	[3]39.00
*Total annual payroll	[2]3	$1,920.00	5	$8,242.00	6	$14,295.66	4	$8,240.33	7	$14,000.00

Note: For comparative purposes, the payroll for all hotels was reduced to a weekly basis.

*There may be a slight difference between this amount and the total based on the rates listed due to overtime and positions not given.

[1] This amount was calculated by us on the basis of 1,680 tons at $7 per ton.

[2] Two days off.

[3] One day off.

[4] Six hours off, lodging and board, twelve working hours.

[5] Colored.

[6] One meal.

TABLE II—ROOM COST OF POWER, HEAT AND LIGHT

Hotel Number	Number of Rooms	Total Cost per Room per Day	Total Cost per Room per Year
2	225	$0.32	$118
9	350	0.31	114
7	300	0.30	110
14	600	0.27	100
3	250	0.27	100
8	300	0.25	92
4	300	0.24	87
5	300	0.23	86
11	450	0.23	85
13	600	0.23	84
10	400	0.23	82
6	300	0.20	75
1	150	0.15	55
Average		$0.25	$91

Note: Hotel No. 12 did not answer the above questions.

Mr. Romine's original paper, of which this is an abstract, was delivered Jan. 8, 1931, before the West Side Association of Hotels, New York City. His analysis of hotel cost data raises some interesting points which are discussed editorially on page 281

maining four on low-pressure. I do not feel competent to discuss the relative advantages and disadvantages of low- and high-pressure steam, but I do point out that the four hotels using low-pressure steam showed an average cost for coal of $18 a room a year, compared with a cost of $30 a room a year in the hotels using high-pressure steam.

The summary in Table III further divides the high-pressure hotels into those making electricity and operating a laundry and those simply operating on high-pressure steam without an electric plant or laundry.

It costs each of the four high-pressure hotels which do not generate electricity or operate their own laundry an average of $9 a room a year more for coal than it does the four low-pressure hotels. If the two high-pressure hotels which operate their own laundries, but have no electric plants, use high-pressure steam just to run the laundries, it adds $11 a room a year, on an average, to their coal bill.

And coal is not the only higher cost found in the hotels using high pressure, for the payroll cost in them is $39 a room a year compared with only $22 in hotels using low pressure.

And so, on the basis of coal and payroll costs, this study proves that it is much more economical to operate with low-pressure steam. [See editorial on page 281—EDITOR.]

ELECTRICAL GENERATION DATA INCLUSIVE

Four hotels generate their own electricity, and the remainder purchase it at an average cost of about 3.5c. per kilowatt-hour. From the figures made available by this study there is no way of proving whether it is cheaper to make electricity or to purchase it.

The study does prove a theory I have always held, namely, that in hotels generating their own electricity the con-

REPLIES TO QUESTIONNAIRE

6	7	8	9	10	11	12	13	14
300	300	300	350	400	450	450	600	600
Low	High	High	High	High	High	Both	High	High
No	No	No	No	No	No	No	No	No
No	No	No	No	Yes	Yes	No	No	Yes
248,110	384,000	250,000	.....	475,000	700,000	.....	759,600	950,000
.....	.....	.....	.....	Yes	Yes	.....	.....	No
.....	.....	.....	.....	$2,640.00	$3,000.00	.....	.....	.....
No. 1 Buck.	No. 1 Buck.	Soft and Dust	No. 1 Buck.	Soft and Screen	No. 2 Buck.	No. 1 Buck.	Soft and Dust	Soft
$6,258.39	$11,760.00	[1]$7,000.00	$12,000.00	$12,250.00	$20,900.00	$7,800.00	$6,000.00	$22,200.00
925	1,680	1,600	1,800	3,000	3,300	1,300	1,500	3,700
$6.75	$7.00	$4.40	$6.80	$4.07	$6.10	$6.00	$3.95	$4.00
9	20	13½	20	22	30	14	9	20
$184.00	$300.00	$360.00	$250.00	$675.00	$560.00	$260.00	$900.00	$390.00
No	No	No	No	No	No	No	No	Yes
No	No	No	No	No	No	Partly	Partly	No
.....	.....	.....	.....	.....	.....	$0.35	$0.32	.....
.....	.....	.....	.....	.....	.....	80,000	706,350	.....
Yes	Yes	Yes	Yes	Yes	Yes	Partly	Yes	Yes
$0.07	.....	$0.05	$0.10	.....	.....	.....	.....	.....
675,000	.....	600,000	525,000	.....	976,000	120,000	.....	600,000[r]
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No	No	No	Yes	No	No	No	No	Yes
No	No	No	No	No	No	No	No	No
No	No	Yes	No	No	No	No	No	Yes
No	Yes	Yes	No	Yes	Yes	Yes	Yes	2
.....	900	1,600	.....	.....	.....	600	7,500	8,000
None	100,000	None	None	.....	.....	None	.....	.....
.....	Yes	.....	.....	Yes	Yes	.....	Yes	Yes
.....	$7,000.00	.....	.....	$5,000.00	$3,000.00	.....	$2,700.00	$1,800.00
.....	$0.07	.....	.....	Edison rates	$0.07	.....	$0.07	$0.06
.....	None	$150.00	None	None	None	None	None	None
.....	$0.25	.....	.....	.....	.....	.....	.....	.....
$5,310.00	$9,960.00	$11,880.00	$9,540.00	$18,000.00	$16,910.00	$14,000.00	$14,820.00	$27,560.00
$22,409.25	$32,880.00	$27,500.00	$40,000.00	$32,890.00	$38,041.00	.....	$50,120.00	$60,113.29

No.	Amount	No	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
1	[6]$39.00	1	[6]$46.00	1	[12]$63.50	1	[13]$52.00	1	[8]$69.00	1	[3]$57.70	1	[8]$54.00	1	$46.00	1	[6]$80.00
.....	.....	1	34.50	1	45.00	.....	.....	1	50.00	1	[15]38.00	1	36.00	1	[2]38.00	3	[6] 45.00 [3]42.00
.....	.....	1	34.50	1	45.00	1	[14]38.00	2	42.00	2	[3]38.00	2	35.00	2	[2]38.00	1	[2]39.00 [3]39.00
1	[10]25.00	1	[5]25.50	1	30.00	1	[16]21.00	1	35.00	1	[3]31.50	1	25.00	1	33.00	3	[2]33.00
1	[10]23.00	1	[7]25.50	.....	.....	1	[16]21.00	2	35.00	2	[3]31.50	1	25.00	1	33.00	1	[2]33.00
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	[3]27.00	.....	.....	.....	.....	1	[3]30.00
.....	.....	.....	.....	1	45.00	.....	.....	.....	.....	1	[3]38.00	1	30.00	1	[2]30.00	3	[3]40.00 [2]35.00
.....	.....	.....	.....	.....	.....	1	[10]16.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	[3]30.00 18.00
.....	.....	1	[3]37.00	.....	.....	1	[11]23.00	.....	.....	1	[3]35.00	.....	.....	1	[2]33.00	.....	.....
1	[11]14.50	.....	.....	.....	.....	1	[10]29.00	1	35.00	1	[3]28.50	1	30.00	.....	.....	.....	.....
4	$5,310.00	6	$9,860.00	5	$11,880.00	7	$9,540.00	8	$18,000.00	12	$16,910.00	8	$14,000.00	8	$14,820.00	13	$27,560.00

[7] Two meals.
[8] Three meals.
[9] One day off, twelve working hours, lodging and board.
[10] One day off, three meals, twelve working hours.
[11] One day off, three meals, relief, twelve working hours.
[12] One day off, two meals.
[13] Three meals, twelve working hours.
[14] Two meals, twelve working hours.
[15] One day off, relief.
[16] One day off, two meals, twelve working hours.

TABLE III—RELATION OF PRESSURE TO COAL COSTS

	Cost of Coal per Room per Year	Number of Hotels	Average Rooms per Hotel
High-pressure hotels:			
Making electricity and operating laundry	$37	1	600
Making electricity, not operating laundry	36	3	370
Operating laundry, not making electricity	29	2	260
Not making electricity, not operating laundry	27	4	390
Low-pressure hotels:			
Not making electricity, not operating laundry	18	4	300

sumption is not controlled as carefully as in hotels where electricity is purchased and the exact cost is reflected each month in the electric bill. The figures show that 1,400 kw.-hr. a room a year were used in hotels generating their own electricity, compared with only 900 in hotels purchasing electricity. Of course, the guests do not know whether the hotel generates its own electricity or not, but the employees do, and they act accordingly.

Table IV supports these figures and also shows the comparative consumption of electricity in each hotel.

TABLE IV—ELECTRICAL CONSUMPTION

	Hotel Number	Number of Rooms	Kw.-Hr. per Room per Year
Generate	11	450	1,600
	14	600	1,600
	3	250	1,400
	10	400	1,200
Average			1,400
*Purchase	7	300	1,300
	13	600	1,300
	2	225	1,000
	4	300	900
	8	300	800
	6	300	800
	5	300	500
Average			900

*Figures submitted by only 7 hotels.

Of the four hotels that generate their own electricity, three are connected with the New York Edison Company's lines for emergency purposes.

Table V presents the annual consumption of coal and the cost per room per year in each hotel.

TABLE V—COAL COST PER ROOM

Hotel Number	High (H) or Low (L) Pressure Steam	Make Electricity	Operate Laundry	Number of Rooms	Cost per Room per Year	Tons per Room per Year
11	H	Yes	No	450	$46	7
7	H	No	No	300	39	6
14	H	Yes	Yes	600	37	6
2	H	No	Yes	225	36	6
9	H	No	No	350	34	5
10	H	Yes	No	400	31	7
3	H	Yes	No	250	30	7
5	H	No	No	300	25	4
8	H	No	Yes	300	23	5
6	L	No	No	300	21	3
4	L	No	No	300	20	3
12	*L	No	No	450	17	3
1	L	No	No	150	15	3
13	H	No	No	600	10	2
Average					$27	5

*H in kitchen

The comparative coal costs in hotels using low-pressure steam and those using high-pressure have been discussed already, the figures being taken from the foregoing table. But there is much more food for thought in the figures. For instance, if I operated hotel No. 7, one of 300 rooms in which a laundry is not run and electricity is not generated, I should want to find out how other hotels of its size can operate at $19 less a room a year for coal. And then, why should the 450-room hotel, No. 11, spend $46 a room a year when a 400-room hotel — generating its own electricity just as No. 11 does—can operate for $31 a room, $15 less? The difference amounts to $6,750. Other similar questions also arise.

All the hotels reported the kind of coal bought and the prices paid. Table VI was compiled from those figures.

TABLE VI—FUEL DATA FOR VARIOUS HOTELS

Hotel Number	Pressure	Number of Rooms	Make Electricity	Kind of Coal	Price per Ton	Tons per Room per Year
7	H	300	No	Buck. No. 1	$7.00	6
9	H	350	No	Buck. No. 1	6.80	5
6	L	300	No	Buck. No. 1	6.75	3
1	L	150	No	Buck. No. 1	6.75	3
5	H	300	No	Buck. No. 1	6.70	4
12	L	450	No	Buck. No. 1	6.00	3
11	H	450	Yes	Buck. No. 2	6.10	7
4	L	300	No	Buck. No. 2	5.90	3
2	H	225	No	*Buckwheat	5.60	6
14	H	600	Yes	Soft	6.00	6
8	H	300	No	Soft and dust	4.40	5
3	H	250	Yes	Soft and dust	4.20	7
13	H	600	No	Soft and dust	3.95	2
10	H	400	Yes	Soft and screenings	4.07	7

*Not reported.

The market price of coal has declined along with the prices on most other commodities, and as the questionnaires were answered some time ago, the prices are out of date. I prepared the table, however, for I thought those using a higher-grade coal, such as buckwheat, would be interested to see the comparative yearly cost per room in hotels using a cheaper coal. Table VII gives the answer in a nutshell.

TABLE VII—SUMMARY OF TABLE VI

Number of Hotels	Kind of Coal	Price per Ton	Tons per Room per Year	Cost of Coal per Room per Year
*10	Buckwheat	$6.40	4.6	$29.44
4	Soft and dust	4.15	5.5	22.82

*One hotel included which reported "soft, $6 a ton."

Only three hotels reported operating their own laundries. It was not the purpose of the study to obtain figures upon which to base conclusions as to whether it is advisable for hotels the size of those considered to operate their own laundries. In considering laundry costs in plants where high-pressure steam is required the cost of the steam should not be overlooked. It would seem that a hotel laundry requiring high-pressure boiler operation might be a liability rather than an asset. Too often, in comparing laundry costs, only direct departmental expenses are taken into consideration and that very important factor of overhead is disregarded.

Big Range in Payroll Costs

To show you at a glance how total heat, light and power payroll compares with those in other hotels Table VIII was prepared.

The causes for the differences in the costs may be traced to the individual positions by referring to the comparative schedule, giving the number of engineers, firemen, electricians, plumbers, etc., in each hotel, together with their salaries. Many interesting comparisons are possible. For instance: In the five 300-room hotels which reported chief engineers are paid as high as $63.50 a week and as low as $46 (room not being furnished). Firemen's salaries range from $21 to $40 a week, electricians' from $30 to $45, etc.

Daily Records of Costs Recommended

I have pointed to the fact that, in hotels generating their own electricity, there is apt to be a feeling that, since the engines must run anyway, a few extra lights here and there do not cost anything, and that because of this, these hotels use over 50 per cent more kilowatt-hours than the hotels in which electricity is purchased.

This illustrates how expensive it is not to realize that every pound of steam wasted in unoccupied rooms, every electric light left burning unnecessarily, costs the hotel real money. A daily record of the consumption of steam, coal, electricity, etc., is one of the best methods of bringing about economy on the part of employees in the use of these items.

In an article which won the first prize in a recent contest conducted by the Hotel Accountants' Association of Chicago, C. E. Reinholt, comptroller of the Hotel Statler, Cleveland, tells how hotel bookkeepers and accountants could help reduce expenses. He says that meter readings should be taken each morning and the consumption figures for the preceding day compared with the records of prior periods. "To secure reductions in consumption it is well to initiate a campaign to that end," he declared. Further on he calls attention to the fact that "It will be found that steam for dish-warmers is on when the dishes in them will not be used for 24 hr. In the cooler months rooms will be heated when they are empty. Bath room doors may not be closed by maids, allowing heat to freely pass from that room through the ventilator. Public rooms are heated unnecessarily when there are no functions in them. Steam tables with poorly fitting tops and pans are wasting steam."

TABLE VIII—PAYROLL FOR HEAT, LIGHT AND POWER

Hotel Number	Number of Rooms	Payroll per Room per Year
3	250	$57
5	300	47
14	600	46
10	400	45
8	300	40
11	450	38
2	225	37
7	300	33
12(L)	450	31
4(L)	300	27
9	350	27
13	600	25
6(L	300	18
1(L)	150	13
Average		$35

(L) Low-pressure steam used.

Tests Made on Carbon Brushes Operating in Hydrogen

A PAPER, "Commutation and Current Collection in Hydrogen," presented at the American Institute of Electrical Engineers' recent winter convention by Robert M. Baker, of the Westinghouse research department, described tests made on commutator machines and slip rings running in hydrogen. These tests were made in anticipation of operating commutator machines, such as rotary converters and exciters, on synchronous condensers in hydrogen. The table gives the results of five brush-life tests made on a 5-hp. direct-current generator. All tests were made with full-load current in the brushes, but the generator was not always adjusted for the same grade of commutation. Tests 1, 2, 3 and 4 were made with 30 per cent of the current shunted from the commutating-pole winding of the generator. The sparking at the trailing edge of the brushes was quite severe, and resulted in rather short brush life even under the most favorable conditions. Test No. 5 was made with almost sparkless commutation.

The most interesting comparison is that between Tests 1 and 2, which were made under identical conditions, except that the former was made in air and the latter in hydrogen. In air the minimum calculated brush life was almost a year, whereas in hydrogen it was only a little more than a week. Furthermore, the damage to the commutator during the test in hydrogen was considerable. The trailing edges of the commutator bars were burned away, leaving a bright metallic surface. In some cases the depression was as much as $\frac{1}{32}$ in. The first test in hydrogen was unusual because it showed such a great difference in wear between the positive and negative brushes.

Effects of Humidity

Tests 3 and 4 were made for the purpose of determining whether the unusually bad behavior of the brushes and the commutator in Test 2 could be attributed to the high relative humidity which was suspected during this test. These tests were made with 30 per cent of the current shunted from the commutating-pole winding of the generator, and the only difference in the two tests was in the relative humidity of the hydrogen atmosphere in which they were run. During Test 3 the relative humidity was maintained at less than 10 per cent, whereas during Test 4 the relative humidity was maintained practically constant at 50 per cent. The table shows that the wear at the higher humidity was approximately four times as great as it was at the lower humidity. An inspection of the commutator gave further evidence of improved performance during the low-humidity test.

Upon shutting down, in Test 3, the commutator appeared dark and uniformly smutted, but apparently no damage had been done. A light application of fine sandpaper showed the commutator to be in good condition. This was not true of the commutator at the end of Test 4. It was apparent immediately upon shutting down after that test that the commutator had been badly burned. The bright copper was showing on the trailing edge of the commutator bars just as it was after Test 2, and the roughness could not be removed by any reasonable amount of sandpapering. Brushes 1 and 4, on the side of the machine nearest the moisture supply, showed somewhat shorter life than Brushes 2 and 3, which were on the other side of the machine. In conclusion, it may be said that if a commutator machine is running in hydrogen and sparking badly, the presence of moisture is detrimental to both the brushes and the commutator.

Brushes Operate Satisfactorily in Hydrogen

The tests described were made with the generator adjusted to give sparking at the brushes, the idea being to determine what would happen if this condition should arise in service. The various troubles encountered under this severe condition should not lead to the belief that commutation in hydrogen is especially difficult, or that it will usually be associated with troubles such as roughened commutator and rapid brush wear. To show that operation in hydrogen may be quite satisfactory when commutating conditions are normal, it is only necessary to refer to Test 5 in the table. This test was made while the generator was delivering full-load current, but the shunt had been removed from the commutating-pole winding. The calculated minimum brush life of almost five years, and the good condition of the commutator at the end of this test, indicate that as long as a machine is designed and adjusted for good commutation in air it will behave quite satisfactorily in hydrogen. This last test was repeated several times, and the same results were always obtained.

Tests of Steel Slip Ring

Tests were made on a tool-steel ring trimmed with different grades of carbon and graphite brushes. The results of these tests were always the same. Lumps of hard material, sometimes 0.02 or 0.03 in diameter, were formed in the brush face, and immediately began to score the ring. Upon analysis the hard material proved to be cementite, apparently formed by a combination of iron and carbon in the presence of localized high temperatures in the contact.

In an attempt to prevent the formation of hard spots in the brush face, a helical groove was cut in the face of the tool-steel ring. With this change it was found that a number of brush grades which failed on the plain ring could be operated without difficulty. The formation of hard particles in the brush face was eliminated and the ring acquired a good polish.

Tests on a brass ring gave results quite similar to those made on the tool-steel ring and were almost independent of the grade of brush used. All grades of carbon and graphite brushes showed a marked decrease in contact drop when the air surrounding the rings was replaced by hydrogen. In fact, the ratio of the contact drop in the air to that in hydrogen was usually greater than ten to one. For most grades of brushes this reduction was permanent, although other grades, after running for a while, began to smut the ring, and when this occurred the contact drop increased to about the same value it would have been in the air.

When it was first discovered that a very low contact drop could exist between a carbon brush and a brass slip ring, it was realized that such an occurrence on the commutator of a direct-current machine might prove disastrous.

CALCULATED BRUSH LIFE OF GENERATOR BRUSHES

Test No.	Duration of Test, Days	Atmosphere	Calculated Brush Life in Days — Brush No. 1	Brush No. 2	Brush No. 3	Brush No. 4
1	15.0	Air	588.0	229.0	812.0	362.0
2	6.41	H	94.4	9.2	128.0	10.6
3	6.78	H	222.0	205.0	282.0	161.0
4	7.0	H	43.7	59.9	69.3	45.0
5	15.0	H	1,87[illegible].0	1,770.0	2,000.0	2,310.0

Brush life is calculated on the assumption of one inch allowable brush wear. Brushes Nos. 2 and 4 are the two positive brushes of the generator and are on opposite brush arms.

As a result, the contact drop of one of the brushes on the generator used in the commutation tests was measured both in air and in hydrogen. The average contact drop in hydrogen was found to be only about 20 per cent less than the contact drop in air, and on the small machine this was not enough to make any visible change in the grade of commutation obtained.

Conclusions

The author stated that even if the tests are not complete, from the results the following tentative conclusions may be made:

1. A commutator machine designed and adjusted for good commutation in air will operate satisfactorily and give good brush life in hydrogen.

2. If a commutator machine must spark in hydrogen, the brush life may be increased many times by keeping the relative humidity below 10 per cent. This will also prevent damage to the commutator.

3. The contact resistance of carbon brushes on a commutator may be materially lowered by the introduction of hydrogen.

4. Carbon or graphite brushes cannot be operated satisfactorily on plain tool-steel slip rings running in hydrogen.

5. The contact drop between a carbon or graphite brush and a brass slip ring may be ten times as high when running in air as when it is running in hydrogen.

WHAT'S NEW IN PLANT EQUIPMENT

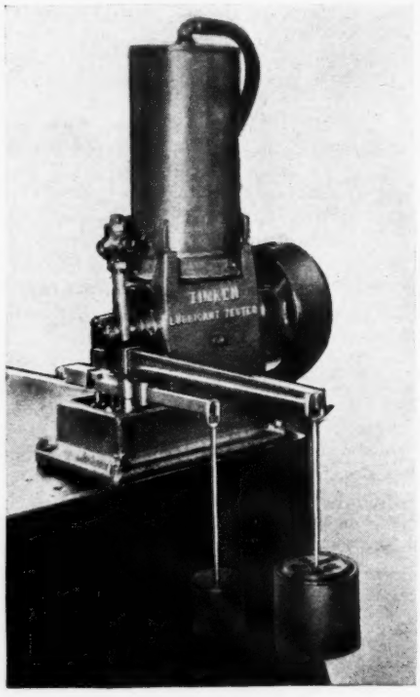
HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Apparatus for Testing Load-Carrying Capacity of Lubricants

ALTHOUGH originally developed for use in the company's own laboratory as means for obtaining information on the effect of different lubricants on certain types of transmissions, the oil-testing apparatus illustrated, put out by the Timken Roller Bearing Company, of Canton, Ohio, has been made available for use in industrial plants, power plants or anywhere that it is desirable or necessary to determine the efficiency of lubricants. In addition it can be used to obtain data on the relative efficiency of different bearing metals under various conditions of load, speed, temperature, or with different lubricants.

The apparatus consists, essentially, of a cast-iron base which supports a testing mandrel, two levers and a container holding about a gallon of the lubricant to be tested. The tank is mounted on top of the base, and below it is an electric heater used to raise the oil to any desired temperature up to 210 deg. The oil flows from the tank, over the test piece, to a sump in the base, the rate of flow being adjusted by a valve in the line. From the sump, the oil is transferred back to the tank by a small pump located in the base. The mandrel is mounted in two anti-friction bearings arranged to hold it rigidly in alignment and is tapered at the test end to receive the tapered cup of a standard roller bearing. This cup, which forms one of the test pieces, is held in place firmly by a nut on the end of the mandrel, which is threaded to receive it.

The lever system consists of two levers, an upper one called the load lever, and a lower one called the friction lever. The upper lever, which carries the test block, is pivoted on a knife edge mounted in the lower lever. The latter is also pivoted on a knife edge and is provided with a stop at the unloaded end. By virtue of this arrangement the test block is always parallel to the revolving cup,



View of machine showing lever arrangement

and the unit loading over the length of both pieces is constant. The test block is a small piece of metal about $\frac{1}{2}$ in. square by $\frac{3}{4}$ in. long hardened to Rockwell C-60 and ground. It is inserted in a notch in the loading lever and held in place by a wedge. In case bearing metals are to be tested, the test block or the cup, or both, can be made of the appropriate material. The friction lever is provided with a vernier scale and a sliding weight for obtaining accurate measurements, and both levers are equipped with hangers for carrying adjustable weights. A welded steel housing is provided to cover the end of the mandrel and levers.

Disconnecting Switch With Double Locking Feature

A LINE of outdoor single-pole hook-stick-operated 4.5-kv. 300-amp. disconnecting switches for inverted mounting is now being put out by the Delta-Star Electric Company, Chicago, Ill.

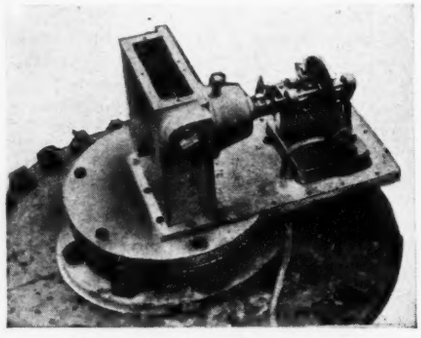
Switch with safety and holding lock

A distinguishing feature of the design is the use of a positive safety lock on the blade and contact clip and a holding lock on the hinge end which firmly secures the blade in open position.

Fluid-Level Indicator

THE MacCreedy fluid-level indicator now being put out by J. H. Bunnell & Company, 215 Fulton St., New York City, consists, essentially, of an indicating instrument and a transmitter. The two instruments may be placed any distance apart, as they are connected electrically only.

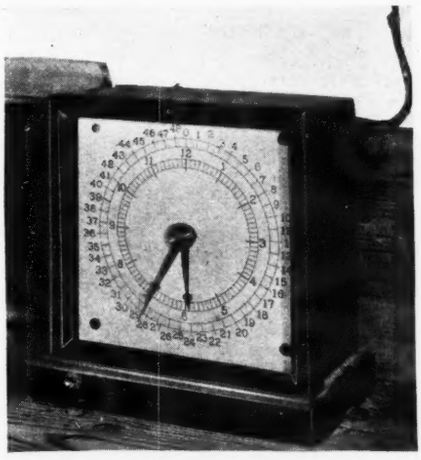
The transmitting system, which is placed on the top of the liquid tank, consists of two floats connected by a



Transmitter mounted on tank

cross bar and arranged to slide vertically on guide wires. The center of the bar joining the floats is connected to the shaft of the transmitting member by a perforated tape. The counterweight for the tape moves up and down in an oil-tight pipe or tube housing; also, the shaft from the pulley to the transmitter is doubly sealed in oil to prevent gas from entering the transmitter chamber. The housing inclosing the transmitter is of heavy construction and is mounted directly on the manhole cover.

Indicators are furnished for shelf or panel mounting. The dial is of porcelain, with large figures, permitting it to be read at considerable distance. The outside scale represents feet, the inside one inches and one-eighth inches.



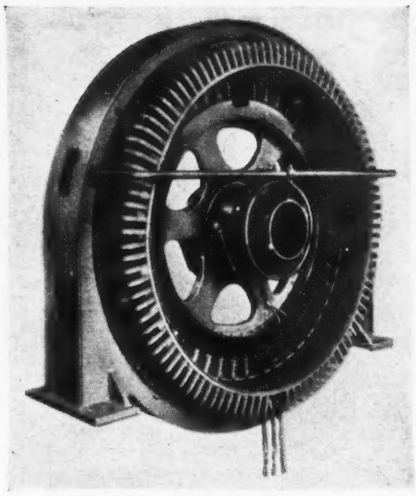
Fluid level indicator

The electrical connections between the two consist of only two wires. When the tank is being filled the impulses furnished by the transmitter cause the indicator to turn clockwise, and counterclockwise when the tank is being emptied .

The system illustrated can be applied to the floating roof type of tanks as well as to practically all other types of tanks of any size.

Line of Motors With Fabricated Steel Stator Frame

ARC-WELDED, fabricated steel stator frame construction is now being used for all medium- and slow-speed synchronous motors built by the Electric Machinery Manufacturing Company, Minneapolis, Minn. A recent change from a two-piece cast-iron stator to a welded steel stator for small-sized motors completes the changeover to fabricated steel frames for the entire line of engine-type and coupled-pedestal-type synchronous motors put out by this company.

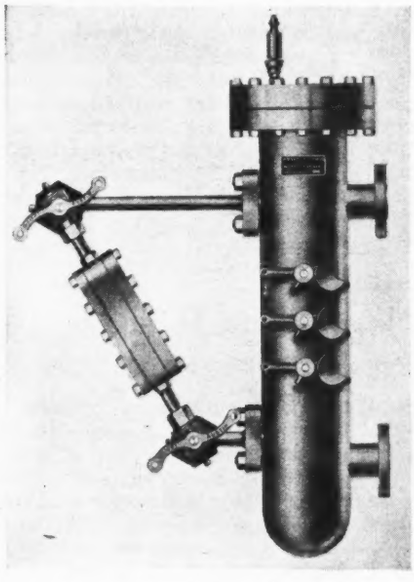


A 125-hp. synchronous motor with arc-welded stator frame

The box-type stator construction is used for the entire line of slow-speed synchronous motors, and is claimed to give increased strength and rigidity, decreased weight and increased ventilation.

Alarm Water Column for 650 Lb. Pressure

THE BODY of the alarm water column recently brought out by the Wright Austin Company, 2231 Park Ave., Detroit, Mich., for 650 lb. working pressure is a single steel forging. The flanges are drop forgings and the stud and bolts are chrome steel. A tongue-and-groove joint connects the cover to the body.



Water column body is a single steel forging

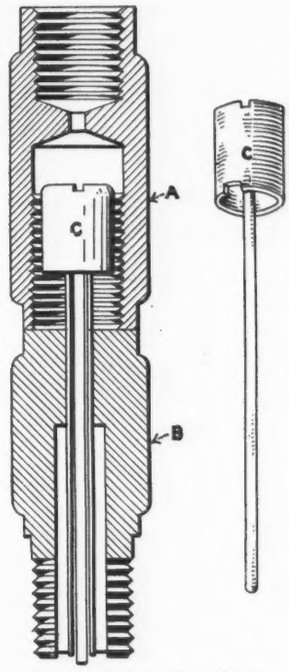
An improved type whistle valve accessible from outside the column, is fitted with Nitralloy valve and seat.

The water gage is connected to the column by heavy bolts and flanges. Three trycocks of chrome steel for 650 lb. pressure, mounted on the side as shown, complete the trimmings of the water column.

Device to Eliminate Vibration in Pressure Gages

TO PROVIDE a simple and practical means of eliminating the vibration of gage hands or pointers and thereby decrease the wear on the working parts of the gage, the device known as a pressure snubber, illustrated, has been introduced by the Ray Pressure Snubber Company, 311 East Fifth St., Charlotte, N. C.

The body of the snubber, which is made in two parts, is inserted in the gage connection at a convenient point. In a recess in the section of the body



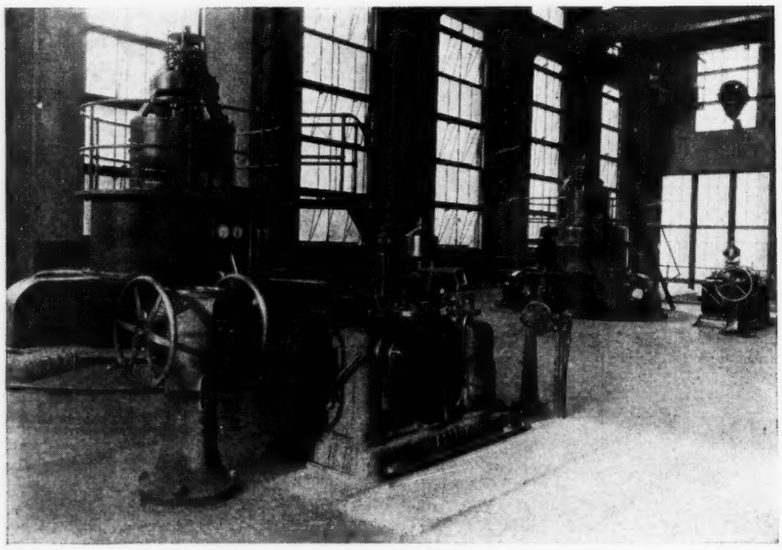
Cross-section of snubber

A the head *C* of what is termed a traveling clearing pin is permitted to float, being guided by a stem sliding in an oversize tube or orifice inserted in *B* as shown. At each pulsation of the flow the clearing pin rises and falls within the tubular orifice. This movement tends to absorb the pulsation and to keep the orifice clear.

Two additional traveling clearing pins of different sizes are supplied with each snubber to take care of unusual conditions. The device can be used for air, water, steam, oil, etc.

NEWS of the FIELD

Second 40,000-Hp. Unit Placed in Service At Oak Grove Hydro-Electric Station



Interior of power house, showing new unit in left foreground

THE NEW No. 2 UNIT in the Oak Grove plant on the Clackamas River, Ore., of the Portland General Electric Company, Portland, went into regular operation on Feb. 1. On that date the No. 1 unit, which has been in practically continuous operation since 1924, was shut down for cleaning and inspection.

The recent installation included an addition to the power house and a second penstock from the surge tank dug into the top of Cripple Creek knoll 900 ft. above the power house.

Identical in capacity with the old, the new G.E. unit has a nominal rating of 30,000 kva. at 85 per cent power factor and generates at 11,000 volts, 60 cycles. The water wheel is a Pelton reaction turbine rated at 40,000 hp. at 849 ft. net head. Static head on the plant is 920 ft. and the two wheels in it are still the highest head reaction turbines in the United States.

The new generator varies in minor respects from the old, having stator coils made up of transposed bar windings for the purpose of equalizing the voltages generated in the top and bottom strands of the conductor, thereby eliminating circulating current in adjacent bars. This construction slightly increases the efficiency of the unit. Also, the new unit is equipped with a surface air-cooler using only the air inside the power house whereas the No. 1 unit, not so equipped, circulates outer air through the coils.

The Oak Grove project was surveyed in 1907. Construction of the first unit was started in 1921 and completed in 1924. The second unit was commenced in March, 1930. The project, as planned, contemplates a third unit of similar size requiring an extension to the power house, a third penstock and a second flow line from the headworks at the dam on Oak Grove Creek to the surge tank.

New York Bill Would Regulate Submetering

REGULATION of submetering companies by the Public Service Commission is sought in a bill introduced recently in the New York State Legislature by Assemblymen Kahan and Stephens. Proposed as an amendment to the public service law, the measure provides that on and after July 1 "no submetering company, either as principal or as agent of a landlord, shall charge, receive or collect from tenants a higher unit rate for like service than that authorized by the rate schedules of the electric company operating in the territory where the charge is made."

It further provides that every submetering company shall provide and maintain facilities for testing electric meters, and that on or before June 30, 1932, all such meters shall be tested, inspected and sealed. If submetering companies require deposits from tenants on meters or for electric service, they must pay tenants the legal rate of interest on all such deposits, according to the bill.

The measure was read once and referred to the Committee on Public Service, pending further action.

Plan $11,000,000 Natural Gas Line for Wyoming

NORTH CENTRAL GAS COMPANY of Casper, Wyo., has been granted a certificate of public convenience and necessity by the Wyoming Public Service Commission, authorizing the construction of a natural gas pipe line from the Big Sand Draw and Muskrat fields in Fremont County to points in Wyoming. It will serve Douglas, Guernsey, Lingle, Torrington, Glendo, Wheatland, Laramie and all intermediate points in the territory embraced within ten miles on either side of its main and branch lines. The gas line will cost approximately $11,000,000. According to the order of the commission, construction of the main and branch lines must begin by March 1, and be completed by March 1, 1932.

P. G. & E. Loses Suit to Farmer Who Dynamited Dam

THREE DECISIONS has been rendered by Judge W. E. Herzinger of the Superior Court of Shasta County (Calif.) in the litigation arising from the dynamiting of the Pacific Gas & Electric Company's Hat Creek dam by Louis P. Joerger, a farmer who claimed that the power company was illegally diverting water from his land riparian to Hat Creek.

On Nov. 10, 1930, the company's wooden dam on Hat Creek was dynamited, and Mr. Joerger frankly admitted that he did the dynamiting. Following that, the P. G. & E. secured a restraining order and injunction forbidding Mr. Joerger from further molesting the dam.

and in return Mr. Joerger applied for an injunction to restrain the company from interfering with the water in Hat Creek. The power company also brought suit against Mr. Joerger for $9,367 to cover the damages to the Hat Creek dam.

The decisions just rendered by Judge Herzinger dissolve the injunction against Mr. Joerger, grant to Mr. Joerger an injunction which restrains the power company temporarily from interfering in any way with the Hat Creek waters, and reject the company's claims for damages on the ground that it has no cause for action against Mr. Joerger for dynamiting the dam.

N. Y. Bill Asks U. S. Gov't To Develop St. Lawrence

A PROPOSAL to have the federal government take over supervision of the development of St. Lawrence power in conjunction with the construction of the proposed St. Lawrence waterway was made in a concurrent resolution introduced in the New York State Legislature Feb. 9 by Senator Warren W. Thayer of the St. Lawrence-Franklin County district.

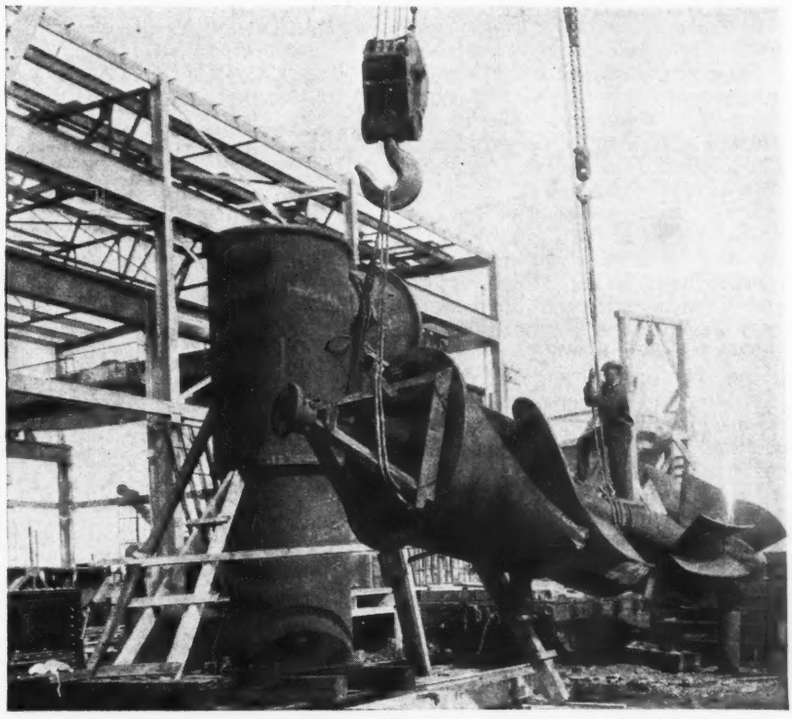
In the preamble it is pointed out that the rapids of the St. Lawrence, on economic grounds, must be developed for both navigation and power and that the governments of the United States and Canada, by taking up the work through their joint engineering board already in existence, could do the work in much shorter time than would be required for the State to do it.

Form Welding Society In St. Louis, Mo.

AT A MEETING held recently in the Forest Park Hotel, St. Louis, the St. Louis Welding Society was formed, and officers elected. This society, which consists of 65 charter members representing 26 companies in St. Louis, East St. Louis, and Madison, Ill., was the outgrowth of monthly meetings on the subject of welding, conducted by the Hill Equipment Engineering Company, St. Louis, representative of the Lincoln Electric Company. Temporary headquarters of the society were established at 4620 Delmar Boulevard, the home of the Hill company.

The following men were elected as officers: president, E. P. Barnes, Moloney Electric Company; vice-president, W. D. Patterson, American School of Welding; secretary and treasurer, Basil N. Osmin, Hill Equipment Engineering Company; directors, F. J. Feldhaus, Heine Boiler Company; Geo. Frankey, Alpha Tank & Sheet Metal Works; A. V. Fausek, Modern Engineering Company; Lyman Goodin, Midwest Piping & Supply Company; F. Tidwell, John Nooter Boiler Works; A. E. Eidson, St. Louis Structural Steel Co.

GIANT PUMP GOING IN FORD PLANT



A shell and propeller of one of the four booster pump units, each of 157,750 g.p.m. capacity, just prior to being lowered for installation in the new water-tunnel pump well at the Ford Company's River Rouge plant

▼ ▼ ▼

Ontario Contracts for 125,000 Hp. From MacLaren

FACED BY ENGINEERS' PREDICTIONS of a possible power shortage in Ontario by 1936, the Hydro Electric Power Commission of Ontario has reached out to tap another Quebec power source in a contract closed with the MacLaren-Quebec Power Company for the delivery of 125,000 hp. at a cost of $1,875,000 per year. The power will be secured from the new hydro-electric development, on which construction is about to start, at Masson Falls, seventeen miles east of Ottawa. The first block of power is to be delivered by July 1, 1933, with increasing quantities annually until the full amount has been taken by November 1, 1936.

The proposed Masson Falls development is the fourth power source to be tapped by the commission in the Ottawa-St. Lawrence district. The other three are the Gatineau River developments, Chats Falls on the Ottawa River and the Beauharnois development on the St. Lawrence. The power included in the contracts with these four companies totals about 1,000,00 hp., all of which will serve to meet Ontario's increasing demands for power for industrial, domestic and rural use.

The contract for the MacLaren-Quebec Power Company's development at Masson, has been awarded to the Foundation Company of Canada, Ltd., Montreal. The new power development with an installed capacity of 130,000 hp. operating under a head of 185 ft., will be an important addition to the hydro-electric plants of the province of Quebec. The work will consist of a dam, control works and intake on the Lievre River, and a tunnel 25 ft. in diameter inside the concrete lining and over a mile long, to be driven through solid rock at a depth of about 200 ft. below the surface.

Order Two 50,000-Kw. Steam Turbines for Moscow Plant

CONTRACT for two 50,000-kw. steam turbine-generators to be installed in the Kaschira power station of the Union of Moscow Electricity Works in Soviet Russia was recently awarded to the Siemens-Schuckert company by the Soviet Trade Delegation in Berlin, Germany. These new units will be of the Siemens-Röder type and will be designed for operation at 1,500 r.p.m. on steam of 355 lb. pressure and 732 deg. F. total temperature.

A 44,000-kw. unit is already in operation in the Kaschira station, and the new machines will raise the installed capacity of the plant to 144,000 kw.

Two 44,000-kw. turbine-generators were ordered some time ago from Siemens-Schuckert for installation in the South Russian steam plant, Sterowka. The first of these is now in the course of erection at the station, the company reports.

Paper Mills Installing New Power Equipment

A NEW 7,000 sq.ft. high-pressure boiler is being installed in the Tonawanda mills at Tonawanda, N. Y., of the Robert Gair Company. The new installation will involve the expenditure of $75,000 and is the first step in a boiler program planned to completely modernize the power plant of the Tonawanda division of the company.

Another addition to power equipment in paper mills is that of the Blandin Paper Company of Grand Rapids, Mich., which has just purchased a 4,000-kw. Allis - Chalmers bleeder - type steam turbine for installation in its new mill. This unit will operate at 200 lb. pressure but is designed for future operation at 450 lb., according to an announcement of the Jacobson Engineering Company of Minneapolis, Minn., which is handling the engineering on the project.

Urge Speed in Gov't Building To Relieve Unemployment

TO HASTEN UNEMPLOYMENT RELIEF, the Office of the Supervising Architect should cease its efforts to prepare all plans and specifications for federal building projects and should assign this task to outside architects and engineers, declares a report transmitted by the American Engineering Council to Col. Arthur Woods, chairman of the President's Emergency Committee for Employment.

Red tape must be cut if the government's building program is to be swiftly carried out, according to the engineers, who urge condemnation instead of negotiation by the Attorney General in acquiring sites, and executive orders by the President to speed the co-operation of departments and bureaus.

The report was prepared by a committee of the American Society of Mechanical Engineers, headed by Ralph E. Flanders of Springfield, Vt., in response to an urgent request by Colonel Woods for aid from the engineering profession.

Power Machinery Exports Drop 20 Per Cent in 1930

EXPORTS of power generating machinery amounted to $15,578,204 in 1930, according to figures made public on Feb. 9 by the Bureau of Foreign and Domestic Commerce of the United States Department of Commerce. Compared with total power machinery exports of $19,379,682 in 1929, foreign sales for 1930 show a decrease of approximately 20 per cent.

Of the total amount exported in 1930, sales of steam engines totaled $5,350,847; foreign shipments of internal combustion engines amounted to $9,464,520, and exports of water wheels and hydraulic turbines totaled $762,837. Comparative figures for 1929 are: steam engines, $7,664,907; internal combustion engines, $11,358,910, and water wheels and hydraulic turbines, $355,865.

Commenting on exports of power machinery for the last five years, the bureau attributes the continuing decrease in foreign shipments of steam engines during that period to competition from other types of prime movers. Internal combustion engines, on the other hand, show a gradual rise from 1926 to 1930, it is pointed out.

COMING CONVENTIONS

American Society of Mechanical Engineers. Semi-annual meeting in Birmingham, Ala., Apr. 20-23. Meeting at Hartford, Conn., June 1-3. National Oil and Gas Power Meeting at the University of Wisconsin, Madison, Wis., June 15-16. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meeting in Pittsburgh, Pa., March 11-13. District meeting in Rochester, N. Y., Apr. 29-May 2. Annual summer convention in Asheville, N. C., June 22-26. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society of Refrigerating Engineers. Spring meeting at the Hotel President, Kansas City, Mo., May 6-8. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Society for Testing Materials. Annual meeting at the Stevens Hotel, Chicago, Ill., June 22-26. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Welding Society. Annual meeting in New York City, Apr. 22-24. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers. Annual meeting and exposition at the Cleveland Public Auditorium, Cleveland, Ohio, June 15-19. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

National Association of Power Engineers. Annual convention and mechanical exposition in the Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago, Ill.

National District Heating Association. Annual convention at the Hotel Statler, Boston, Mass., June 2-5. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 8-12. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

Third International Conference on Bituminous Coal. At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

Universal Craftsmen Council of Engineers. Annual convention at the Stevens Hotel, Chicago, Ill., Aug. 4-8. Grand Secretary, T. H. Jones, 33 Linden Ave., Cherrydale, Va.

Personal

JOHN R. FREEMAN, internationally known hydraulic engineer and past president of both the American Society of Mechanical Engineers and American Society of Civil Engineers, was awarded honorary membership in the latter society at its recent annual meeting.

W. P. DAUGHERTY, for the past seven years assistant superintendent of power of the Kansas Gas & Electric Company, has been appointed superintendent of power to succeed C. LEE KARR, who has assumed new duties in North Carolina. Mr. Daugherty became identified with Kansas Gas & Light ten years ago after a connection with the Pacific Power & Light Company. Prior to that he had been associated with the Union Electric Light & Power Company of St. Louis.

W. W. MCCREARY, president of McCreary's, Ltd., of Brandon, Manitoba, has been appointed manager of the Canada Gas & Electric Light Company's station that was recently taken over by the Manitoba Power Commission. Mr. McCreary entered the power field in 1906 as manager of the plant at Treherne. Later he went to Winnipeg and was employed at the standby plant of the Winnipeg Electric Company.

DR. VLADIMIR KARAPETOFF, professor of electrical engineering at Cornell University, has been granted a leave of absence for one year by the university to collect and co-ordinate the results of all recent research on insulation. He hopes to make electric power cheaper through the improvement of electrical insulation.

C. D. MEALS, formerly chief engineer of the American Cable Company and wire-rope engineer of the Roebling Company, is now president and general manager of the newly formed Wire Rope Corporation of America, Inc., of New Haven, Conn. He will have identified with him in an engineering capacity A. F. HAURY, formerly associated with the American Cable Company and the American Steel & Wire Company.

F. C. BIGGERT, JR., vice-president of the United Engineering & Foundry Company of Pittsburgh, Pa., has been appointed a member of the American Society of Mechanical Engineers Research Committee for the term 1930-1935. Mr. Biggert takes the place made vacant by the retirement of ROBERT L. STREETER, vice-president of the United States Aluminum Company, whose five-year term expired last year.

H. M. LYSTER, for the past five years secretary of the Canadian Electrical Association, has resigned to accept the position of general manager of the Dominion Welding Engineering Company, Ltd., of Lachine, Quebec. B. C. FAIRCHILD has been appointed secretary of the association to succeed Mr. Lyster.

Business Notes

THE KING COMPANY, Owatonna, Minn., announces the appointment as general sales manager of B. T. Land, who has had a wide experience in the heating and air-conditioning field during the past several years. Extensive plans for expansion in 1931 have been laid by Mr. Land, it is announced, and the field sales organization of the company will be doubled.

GOULDS PUMPS, INC., Seneca Falls, N. Y., announces that H. W. Foulds, assistant to the president, has been placed in general charge of all sales. Mr. Foulds was formerly connected with Servel, Inc., as vice-president.

GENERAL REFRACTORIES COMPANY, Philadelphia, Pa., announces the appointment of the West Allis Fuel & Supply Company of West Allis, Wis., as distributors of its products in Milwaukee and Waukesha counties. This new distributor will handle the products manufactured in the Evans & Howard division of the General Refractories Company, which is located in St. Louis, Mo.

FRANK B. STEELE, electrical engineer, announces the opening of a consulting engineering office at 10 Hopper St., Utica, N. Y., for the general practice of engineering. Mr. Steele will specialize in heating, power, electrical and pumping problems.

DIAMOND ELECTRICAL MANUFACTURING COMPANY, LTD., announces the removal of its San Francisco, Calif., plant from 1264 Folsom Street to 130 Potrero Avenue.

How's Business?

EVIDENCES of much trade improvement are still slight but perhaps sufficient to excuse the recent eager turn of stock-market sentiment. A rising backlog of steel orders, somewhat better than seasonal levels in carloadings, bank debits, currency in circulation and commercial loans, a firming of some commodity prices and increasing bank bond investments are encouraging. Yet our index of general business for the first week of February at 76.8% of normal shows little change from the low level at the end of January. The passing of the bonus bogey, settlement of the relief squabble and prospects of early lifting of the congressional incubus probably have helped betterment of business feelings.—*The Business Week*, Feb. 18.

WITH THE SOCIETY SECTIONS

A.S.M.E., Anthracite-Lehigh Valley Section. Meeting in the ballroom of the Sterling Hotel, Wilkes-Barre, Pa., Feb. 20 at 8 p.m. Subjects: "Research in Anthracite," by Prof. H. G. Turner, Lehigh University; "Development of the Hardinge Mill With Particular Reference to the Problems That Have Been or Must Be Overcome for the Successful Commercial Use of Pulverized Anthracite," by H. C. L. Miller, Fuller Lehigh Company.

A.S.M.E., Boston Section. Inspection trip to Edison Plant, followed by meeting at the Engineers Club, Feb. 18 at 7:30 p.m. Subject: "Central Heating in Boston," by D. S. Boyden and M. D. Engle, Edison Electric Illuminating Company of Boston.

A.S.M.E., Metropolitan Section. Power Division meeting in Room 501, Engineering Societies Building, on Feb. 24 at 8 p.m. Subject: "Some Suggestions Regarding Harmonious Relationships Between Boiler Water and Metal," by R. E. Hall, Hall Laboratories, Inc.

A.S.M.E., Philadelphia Section. Meeting at the Engineers' Club on Feb. 21 at 8 p.m. Subject "Research in Industry," by C. F. Hirshfeld, Detroit Edison Company. The meeting will be preceded by dinner at 6 p.m.

A.S.H.V.E. and A.S.R.E., Boston Sections. Joint meeting at the Boston Chamber of Commerce on Feb. 26 at 6:15 p.m. Subject: "Air Conditioning," by D. C. Lindsley, Carrier Corporation.

Trade Catalogs

CAR DUMPERS—Bulletin No. 93, recently issued by the Wellman Engineering Company, Cleveland, Ohio, describes and illustrates the Wellman revolving car dumpers for handling coal, ash, ore and other materials at mines, power and industrial plants.

PIPE WELDING—The A. O. Smith Corporation, Milwaukee, Wis., has just issued a new bulletin, No. 510, entitled "The New Way of Designing and Building Gas Lines." The first part of this booklet is devoted to an exposition of the relation of pipe diameter to pipeline capacity. Many charts are included to permit the easy calculation of pipe capacities, pressures and stresses. The second portion of the publication contains many illustrations of actual pipeline construction.

SPEED REDUCERS—Foote Bros. Gear and Machine Company, 111 North Canal St., Chicago, Ill., is issuing a new data book and catalog on its line of "Hygrade" worm-gear speed reducers. The book is divided into three sections, the first section being devoted to an interesting discussion of the evolution of worm gearing. The second section, entitled "The Customers Problem," discusses the questions of design, materials manufacturing methods and selection of units from the customers angle. The third section of this 80-page book contains valuable engineering data, tables, curves, formulas and typical problems.

DIESEL ENGINES—"Large Diesels for Public Utilities" is the title of a profusely illustrated bulletin recently issued by the Busch-Sulzer Bros.-Diesel Engine Company, St. Louis, Mo., which describes the advantages of using large diesel engines for the generation of electric power. Sketches of typical plant layouts together with many photographs of actual installations are included in the bulletin.

Fuel Prices

FUEL OIL

New York—Feb. 11, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, contract, 6c. per gal.

St. Louis—Feb. 4, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.339 per bbl., or 42 gal.; 26@28 deg., $1.464 per bbl.; 28@30 deg., $1.589 per bbl.; 30@32 deg., $1.689 per bbl.; 32@36 deg., gas oil, 3.901c. per gal.; 38@40 deg., distillate, 4.526c. per gal.

Pittsburgh—Feb. 4, f.o.b. local refinery, 34@36 deg., fuel oil, 3.125c@ 3.5c. per gal.; 36@40 deg., 3.125c.@3.5c.

Philadelphia — Feb. 2, No. 4, light, $1.31 per bbl.; No. 5, medium, $1.22; No. 6, heavy (Bunker C) $1.10.

Cincinnati—Feb. 2, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.5c. per gal.; 26@30 deg., 4.75c. per gal.; 30@32 deg., 5c. per gal.

Chicago—Jan. 16, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 18@22 deg., 60c. per bbl.; 22@26 deg., 67.5c. per bbl.; 26@30 deg., 80c. per bbl.; 30@32 deg., 95c. per bbl.; 32@36 deg., gas oil, 2.25c. per gal.

Boston—Feb. 9, tank-car lots, f.o.b. 12@14 deg., Baumé, 3c. per gal.; 28@32 deg., 5c. per gal.

Dallas—Feb. 7, f.o.b. local refinery 24@26 deg., $1.10 per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol.	New York	$1.90 @ $2.25
Pool 10, h. gr. low-vol.	New York	1.75 @ 1.85
Pool 11, low-vol.	New York	1.60 @ 1.75
Smokeless, mine-run	Chicago	1.75 @ 2.25
Smokeless, slack	Chicago	.75 @ 1.35
Harlan, Ky., slack	Chicago	.70 @ 1.00
Franklin, Ill., mine-run	Chicago	2.15
Franklin, Ill., screen	Chicago	1.50 @ 1.60
Ind. 5th Vein, m.-r.	Chicago	1.50 @ 1.85
Standard Ill., mine-run	St. Louis	1.50
W. Ky., mine-run	Louisville	1.25 @ 1.50
W. Ky., slack	Louisville	.30 @ .40
Pittsburgh, mine-run	Pittsburgh	1.35 @ 1.45
Smokeless, mine-run	Cincinnati	1.75 @ 2.00
Smokeless, slack	Cincinnati	.75 @ 1.35
Kanawha, mine-run	Cincinnati	1.10 @ 1.35
Kanawha, nut-slack	Cincinnati	.50 @ .75

Anthracite (Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.50
Barley	New York	1.50

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ark., Hot Springs — Syndicate, c/o G. K. Bartling, Inc., 567 Paul Brown Bldg., St. Louis, Mo., awarded contract for an 8 story hotel, etc., to Hercules Contracting Co., Wainwright Bldg., St. Louis, Mo. Steam heating system, elevators, etc., will be installed.

Calif., Glendale—City appropriated $108,000 for sub-station equipment for San Fernando and Grand View stations, overhead system, line transformers and devices, underground conduits, meters, etc., in connection with municipal light department.

Calif., Los Angeles—City is having plans prepared for sewage treatment work including pumping plants, etc. F. L. Weisenheimer is assistant chief engineer.

Calif., Redwood City—Pacific Gas & Electric Co., 445 Market St., San Francisco, awarded contract for the construction of a group of service buildings, here, to Clinton-Stephenson Co., Monadnock Bldg., San Francisco. Estimated cost $40,000.

Calif., San Bernardino — Southern Sierras Power Co., c/o California-Nevada Electric Co., Riverside, awarded contract for power transformer and sub-station equipment here, also condensers, transformers and power plant equipment at Las Vegas, Nev., to Westinghouse Electric & Mfg. Co., 150 Broadway, New York. Estimated total cost $100,000.

Calif., Tulare—Tulare Public Utility Board, is having surveys made for the construction of a municipal light and power plant. Tentative estimated cost $3,000,000.

D. C., Washington — Dept. of Commerce, Bureau of Lighthouses, Airways Division, will build an air communication station to house transmitting equipment to consist of a 2 kw. broadcast transmitter and ½ kw. high frequency transmitter supported by two 125 ft. towers at Little Rock, Ark. Similar stations will be constructed at Birmingham, Ala., Shreveport, La., Jackson, Miss., Jacksonville, Fla., Eutawville, S. C., and Amarillo, Tex. Also plans radio range beacon station including 1.5 kw. unit power and 5 kw. 500 cycle motor generator at Little Rock. H. J. Walls, c/o owner, airways radio engineer. F. C. Hingsburg, c/o owner, is chief engineer. Work will be done by owner's forces.

Ind., Anderson—City plans improvements to electric light plant, including rebuilding No. 4 boiler, work on switchboard, etc. Estimated cost $50,000. H. Gwinnup, Anderson, is engineer.

Ind., Fort Wayne—Bd. of Public Works, will receive bids until Feb. 24 for waterworks improvements, including reservoir, filtration plant, pumping station, etc. Estimated cost $150,000. Hood, Decker, Shoecraft & Drury, Ann Arbor, Mich., are engineers.

Ind., Richmond—City plans extensions and improvements to municipal electric light plant. Estimated cost $859,100.

Ia., Cedar Rapids—City will soon receive bids for sewage system including pumping station, etc. Estimated cost $150,000. F. E. Young, City Hall, is engineer.

Ia., Fort Dodge—Fort Dodge Gas & Electric Co., T. C. Roderick, Mgr., awarded contract for a 2 story, 35 x 75 x 65 ft. addition to power plant to United Light & Power Engineering & Construction Co., c/o owner. Estimated cost including equipment $300,000. Equipment contracts let.

La., New Orleans—New Orleans Public Service Inc., 317 Barrone St., plans the following construction work during 1931: extending power system to serve industrial consumers, $30,000; metering and regulating station on Independence St., $15,300; new services, $30,000; new meters, $90,000.

Me., West Pownal—State School for Feeble Minded, V. E. Vosburgh, plans additions to power house and laundry. Estimated cost $45,000. Architect not selected.

Mass., Gardner—Dept. of Mental Diseases, plans the construction of a new heating plant at State Hospital. Estimated cost $150,000. Private plans.

Mass., Taunton — Dept. of Mental Diseases, plans boiler room improvements at State Hospital. Estimated cost $40,000. Private plans.

Mass., Westboro—New England Power Association, 89 Broad St., Boston, awarded contract for the construction of a sub-station here to New England Power Construction Co., 89 Broad St., Boston.

Mich., Detroit—Bd. of Education, C. A. Gadd, Bus. Mgr., 1354 Broadway Ave., will receive bids until Feb. 18 for a 2 story addition to school, including power house with boilers and equipment on Freeland Ave. Estimated cost $232,800. Stratton & Hyde, 904 Marquette Bldg., are architects.

Neb., Omaha — Douglas County, G. Berger, Clk., awarded contract for a 5 story county hospital at 42nd and Woolworth Ave., to V. Ray Gould & Son, City National Bank Bldg. Estimated cost $750,000. Steam heating, ventilation systems, etc., will be installed.

N. J., Holmdel — Dept. of Institutions & Agencies, W. Ellis, Comr., State Office Bldg., Annex, Trenton, is having revised plans prepared for the construction of a reception and treatment hospital, including steam heating and ventilation systems, boilers, etc., at New Jersey State Hospital here. Estimated cost $1,000,000.

N. J., Jersey City — Bd. of Commissioners, City Hall, awarded contract for the construction of a 12 story staff house at Baldwin and Montgomery Sts., to James Mitchell, Inc., 24 Journal Sq. Estimated cost $850,000. Steam heating system, etc., will be installed.

N. Y., Creedmore—Dept. of Mental Hygiene, State Capitol, Albany, awarded contract for electric connections and power house equipment at Brooklyn State Hospital here, to T. F. Jackson, 25 West 43rd St., New York, $97,850.

N. Y., New York — U. S. Trust Co. and Bankers Trust Co., 45 Wall St., plan the construction of a bank and office building at Wall and Nassau Sts. Estimated cost $5,500,000. Shreve Lamp & Harmon, 11 East 44th St., are architects. Maturity about May 1.

N. D., Williston — Great Northern Railway Co., Railroad Bldg., St. Paul, Minn., awarded contract for superstructure of power plant here to C. U. Steen Co., Grand Forks. Estimated cost $80,000.

Okla., Enid—Oklahoma Gas & Electric Co., 321 North Harvey St., Oklahoma City, is having preliminary plans prepared for the construction of a new sub-station here. Estimated cost $25,000. Byllesby Engineering Co., 231 South La Salle St., Chicago, Ill., is engineer.

Okla., Medford—City is having plans prepared for the construction of a municipal electric light plant. Estimated cost $25,000. Engineer not announced.

Okla., Oklahoma City—E. A. Liebman, 1214 West 18th St., is having preliminary plans prepared for a 100 ton raw water ice plant at Klein and Reno Sts. Estimated cost $100,000. Private plans.

Pa., Pittsburgh—John McSorley, 5562 Hobart St., is having plans prepared for a 16 story apartment building, including vapor heating system, mechanical refrigeration system, etc., at Bigelow Blvd. and Dithridge St. F. Stanton, 307 North Michigan Ave., Chicago, Ill., is architect.

R. I., Burrillville—State Sanatorium, H. L. Barnee, Supt., plans additions and alterations to sanatorium including nurses' home, refrigeration plant, laundry, etc. Estimated cost $40,000. Architect not selected.

Tex., Brownwood—Brown County Water Improvement District, is having plans prepared for a large pumping system for pumping water from irrigation canal into irrigation lines and also pumping water into main lines of municipal water system. D. W. Ross, San Antonio, is engineer.

Tex., Eagle Pass—Central Power & Light Co., National Bank of Commerce Bldg., San Antonio, is having surveys made for the construction of a hydro-electric plant, 10,000 hp. capacity on irrigation canal near Rio Grande River. Estimated cost $1,500,000. Harzo Engineering Co., 20 North Wacker Dr., Chicago, Ill., is engineer.

Tex., Galveston—Gulf Colorado & Santa Fe Ry. Co., will soon receive bids for the construction of an 8 story office building, including 29 x 52 ft. boiler house. Estimated cost $1,000,000. K. B. Duncan is chief engineer.

Tex., Lubbock—Texas Technological College, W. T. Gaston, will receive bids until Feb. 18 for the construction of a power plant. Estimated cost $20,000. W. C. Hedrick, 1005 First National Bank Bldg., Fort Worth, is engineer.

Tex., Wharton—City voted $12,000 bonds for waterworks improvements including new pumping equipment, etc. A. H. Armstrong, Mayor.

Virginia—Virginia Electric & Power Co., 7th and Franklin Sts., Richmond, plans to expend $4,000,000 during 1931 for improvements, including booster station, electric line extensions, etc., in Richmond, Petersburg, Norfolk, Portsmouth and Fredericksburg.

Man., Churchill—Dept. of Railways & Canals, Ottawa, Ont., awarded contract for power plant buildings here, to Carter-Halls-Aldinger Co. Ltd., Winnipeg, Man., $174,000.

Que., Masson—Maclaren-Quebec Power Co. of Canada, Ltd., Buckingham, awarded contract for the construction of a hydro-electric power development on the Lievre River to develop 130,000 hp. Plans include power house, dam, control works, intake and tunnel, 25 ft. in diameter, to Foundation Co. of Canada, Ltd., Montreal.

Que., Montreal—Beauharnois Power Corp., Ltd., R. A. C. Henry, V. Pres. and Gen. Mgr., University Tower, awarded contracts for electrical equipment including motor generator sets, hoists, and low tension circuit breakers to Canadian General Electric Co., 212 King St. W., Toronto, Ont., and William Hamilton, Ltd., Canada Cement Bldg., Montreal. Contracts for exciters, switchboards and high tension circuit breakers will be let later.

Equipment Wanted

Engine—Gridley, Calif.—City will soon receive new bids for a Diesel engine. Former bids rejected.

Motors, Air Compressor, etc.—Boston, Mass.—Gerard Electric Co., 101 Pearl St., plans to purchase electric motors, air compressors, etc.

Oil Circuit Breakers, Transformers, etc. — Cleveland, O.—City will receive bids until Feb. 20 for oil circuit breakers, control panels and instrument transformers for municipal light plant.

Pumping Equipment—El Nido, Calif.—El Nido Irrigation Dist., A. L. Cowell, Secy., will receive bids until Feb. 25 for pumping equipment, etc., in connection with canal system.

Pumping Equipment—New York, N. Y.—Bd. of Transportation, H. Delaney, Chn., will receive bids until Feb. 20 for furnishing and installing pumping equipment on Routes 106 and 108, Boroughs of Bronx and Queens.

Pumps, etc.—Chatham, Ont.—City plans to purchase electric pumps, etc., in connection with waterworks. Estimated cost $25,000.

Refrigerators — Fresno, Calif. — City, D. M. Barnwell, County Clk., will receive bids until Feb. 27 for brine refrigerators for remodel of refrigerating system at County General Hospital.

Switchgear—Wellington, N. Z.—Dept. of Public Works, will receive bids until May 5 for 66,000 v. and 33,000 v. outdoor switchgear for Lake Coleridge. Also until Mar. 17 for 11,000 v. switchgear and metering equipment for controlling a 15,000 kva. sub-station.

Industrial Projects

Calif., Avon — Associated Oil Co., 79 New Montgomery St., San Francisco, subsidiary of Tidewater Associated Oil Co., 17 Battery St., New York, N. Y., awarded contract for a 1 story boiler house here to Villadsen Bros., 417 Market St., San Francisco, $12,000, also plans a booster plant at Coalings. Estimated cost $50,000. Maturity indefinite.

Calif., Onfario — Edison Electric Appliance Co., 5600 Taylor St., Chicago, Ill., plans the construction of a plant for the manufacture of electric ranges here. Estimated cost $250,000.

Del., New Castle — Intercontinental Pipe & Mining Co., 122 East 42nd St., New York, N. Y., c/o Herbert Kennedy Cast Iron Pipe Co., plans reconditioning and equipping steel plant here. Estimated cost $1,000,000.

N. J., East Rutherford — East Rutherford Syringe Co., 75 Mozart St., E. Rutherford, is having plans prepared for a 2 story factory at 54 Mozart St. Estimated cost $40,000. J. T. Camlet, 26 Piaget Ave., Clifton, is architect.

N. C., Charlotte—Swift & Co., Packers and Exchange Aves., Chicago, Ill., are receiving bids for a refrigeration warehouse and distribution system. Estimated cost $40,000. Private plans.

N. C., Gastonia—Groves Mills Inc., awarded contract for the construction of a dyeing and finishing plant on Lowell Rd. to A. H. Guion Co., Gastonia. Estimated cost $50,000.

O., Canton—Union Metal Mfg. Co., 1432 Walnut Ave. S. E., awarded contract for a 1 story, 60 x 340 ft. factory on Maple Ave. N. E., to Hiner Structural Steel Co., 332 2nd St. N. W. Estimated cost $40,000 to $50,000.

Ore., Portland—Beaver Wood Products Co., will build a 1 story, 48 x 258 ft. mill for the manufacture of wood specialties at Steel Ave. between 24th and 25th Sts. Estimated cost $41,000. Work will be done by day labor. Woodworking equipment will be required.

Tex., Beaumont—City, c/o P. Millard, Mgr., plans the construction of a loading and unloading wharf, 1,100 ft. x 36 ft. wide. Estimated cost $600,000. R. C. Black, City Hall, is engineer. Machinery and equipment will be required.

Ont., Fergus — Beatty Bros., plans two 1 story, 50 x 100 ft. additions to factory for the manufacture of agricultural machinery. Estimated cost $100,000. Private plans.